NYS·TEC

NEW YORK STATE TECHNOLOGY ENTERPRISE CORPORATION

presents its Draft Final Report for

Building a Bridge to the Corn Ethanol Industry

Subcontract No. ZXE-9-18080-05

Submitted to:

National Renewable Energy Laboratory (NREL)
1617 Cole Boulevard
Golden, CO 80401-3393

December 31, 1999
Revision 0

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Executive Summary

Historically, most ethanol produced in the United States is produced from corn. NREL has done extensive work over the past few years to develop the Lignocellulosic Biomass to Ethanol Process. Utilizing this technical process, many agricultural products or food-processing-waste products can be used to produce ethanol

Although ethanol is not currently being produced in New York State, the diversity of the agricultural and forestry industries here presents a wide range of potential feedstocks for ethanol production. Under this study, the New York State Technology Enterprise Corporation (NYSTEC) Alternative Fuel Technology Center (AFTC) has evaluated NREL's Lignocellulosic to Biomass technology against the New York State feedstock supply. Along with our subcontractors, Raytheon Engineering and Constructors, we have assessed the technical and economic feasibility of using this technology to produce fuel ethanol in New York State. The results of our study are contained in this report.

Our study targeted at an existing grain processor, Robbins Corn and Bulk Service. NYSTEC's study concludes that although the Robbins facility is not an appropriate site for ethanol production, New York State grows enough corn stover, hay and straw to produce 240 million gallons of ethanol annually using the lignocellulosic technology. The overall economics, however, have not been found to be promising at this time. Plant construction costs of $230 million have been estimated under this study. Due to those significant capital costs, our financial pro formas and the results of our sensitivity analysis indicate that the plant would not be profitable until its 20th year. As a result, the sale price of ethanol for fuel use could not compete with existing mid-west prices.

Results of this report conclude that New York State ethanol production is feasible and that ways to make it affordable should be pursued further. NYSTEC remains confident that, in the long run, the Lignocellulosic Biomass to Ethanol process will be "the way to go" in fuel ethanol production. This is due to the fact that production will not directly compete with the food supply and that feedstocks will tend to be cheaper to produce and obtain. NYSTEC is also encouraged that the results of this and other NYSTEC studies indicates that the production and use of ethanol as a cleaner, renewable replacement for fossil fuels has significant economic and environmental potential in New York State.

At the end of this report, NYSTEC has outlined ideas for projects that will help to address the affordability issue identified in our analysis. We look forward to discussing these ideas with NREL to determine mutual interest and potential benefits.

1. FEEDSTOCK ANALYSIS

1.1 Introduction

Many agricultural products or food-processing-waste products can be used to produce ethanol. With its diverse agricultural and forestry industries, the Northeast has a wide range of potential feedstocks for ethanol production. In addition to analyzing corn and corn stover, NYSTEC assessed the potential to utilize a wide range of feedstocks that are available in the region. These include not only other biomass feedstocks but also waste products from processing of agricultural crops.

Feedstocks can be separated into two major categories: starch based and biomass. Starch-based feedstocks include corn and most processing wastes. These feedstocks are converted to ethanol through a traditional fermentation process that removes sugars and ferments them to yield ethanol and carbon dioxide. Biomass feedstocks include corn stover, paper-mill wastes, hay, and grasses. Biomass feedstocks have not yet been converted to fuel ethanol in a production-scale facility. However, promising new technologies, like that developed by NREL, are coming to the forefront of the ethanol industry. By using a process that employs cellulase enzymes to break down the cellulose in biomass feedstocks for conversion into ethanol, these technologies promise to make a whole new array of lower-cost feedstocks available to the fuel-ethanol production industry. Many biomass feedstocks are currently not highly valued for other processes. Some are waste products. Therefore, biomass-to-ethanol processing may hold the key to achieving economies capable of overcoming the continued reliance of the ethanol industry on federal subsidies.

For each feedstock, NYSTEC examined a number of factors — including quantities available, purchasing costs, transportation costs, and composition. Noting the strong potential that exists in the Northeast to expand feedstock production, NYSTEC also studied former agricultural lands that have reverted to forests or uncultivated fields since 1969. These lands may be available for a return to income-producing status to grow additional feedstocks for use in producing ethanol.

1.2 Feedstock Quantities

Feedstock data was collected from a wide variety of sources. Data on feedstock quantities was mainly gathered from New York State agricultural statistics (see Table 1). Feedstocks are generally supplied to an ethanol plant from within a 35- to 75-mile radius of the plant. For this study, NYSTEC limited feedstock usage to feedstocks found within the four counties that make up the majority of land within 50 miles of the grain processor, Robbins Corn and Bulk Service (RCBS). NYSTEC designated this area the 'North Country Region,' which encompasses Jefferson, Lewis, Oswego, and St. Lawrence counties in upstate New York. The production of corn and other feedstocks, as well as the amount of available land, were also quantified on a statewide basis for comparison purposes.

1.3 Feedstock Composition

The data on the composition of the feedstocks was gathered through review of literature, which included research reports, textbooks, etc., and through telephone interviews with experts from the industry. See Appendix A (Feedstock Composition) for a complete assessment.

Table 1, Feedstock Production Quantities (1993-1998 Average Yield)

Feedstock Type	Robbins Corn and Bulk Service (RCBS)	North Country Region	New York State
Brewery Solids (dry tons)	0	0	2,901,690
Cheese Whey (dry tons)	0	74,179	219,853
Corn (tons)	1,962	69,185	1,859,200
Corn Silage (tons)	1,246	1,202,420	7,779,200
Corn Stover (tons)	1,339	49,720	1,208,000
Fruit Pomace (wet tons)			
Apples	0	0	46,132
Cherries	0	0	1283
Grapes	0	0	77,195
Papermill Residue (wet tons)	0	151,000	643,000
Straw (tons)	212	2,978	294,740
Grass (tons)	750	354,740	1,848,000
Vegetable Waste (wet tons)			
Beets	0	0	17,045
Cabbage	0	0	19,240
Carrots	0	0	8,218
Peas	0	0	3,767
Snap Beans	0	0	14,281
Sweet Corn	0	0	149,856
Willow Biomass (dry tons)	0	0	230
Winery Waste (dry tons)	0	0	18,853

1.4 Feedstock Costs

Cost data for farm feedstocks is based upon discussions with local farmers and is supported by data from New York State agricultural statistics. Cost data for non-farm feedstocks is based on discussions with feedstock producers, state government personnel, and research data. Transportation costs for most feedstocks are included in feedstock costs. For feedstocks that did not have transportation costs included, those costs were estimated based upon data provided by local farmers and by the U.S. Department of Agriculture. See Appendix B for feedstock costs, to include transportation costs.

Data on agricultural land availability was based on the New York State Census of Agriculture and on a Cornell University report titled, "The Return of Agricultural Lands to Forest." Based on data extrapolated from these sources, NYSTEC created reliable estimates of acres of land removed from agricultural production between 1969 and 1997.

For each feedstock, data sheets that identify the data sources and contain information about production in the regions and costs are provided in Appendix B (Feedstock Cost).

1.5 Individual Feedstocks

1.5.1 Corn

Corn is a primary feedstock in most ethanol production plants in the United States. The corn-to-ethanol production process uses a well-documented and proven technology to produce over 860 gasoline-equivalent million gallons of ethanol per year for the oxygenate, additive, and alternative-fuel markets. New York's grain-corn production in 1997 totaled 75.4 million bushels, up 22.8% from the 1996 level. As a result, New York State had a feed-grain surplus in 1997 after running deficits for many years. Changes in the State's dairy industry have created the need for new markets for corn. The decline in the number of grain-consuming animal units and in the quantity of grain fed per animal may require farmers to curtail corn production and result in a concurrent reduction in farm income. Ethanol production within New York State would increase the demand for corn, provide a promising new market, and stimulate farm income.

The feedstock data sheets in Appendices A and B provide detailed analysis of corn production, corn costs, and chemical composition. As a key feedstock for an ethanol plant, corn is a commodity that experiences price variations that must be carefully monitored. NYSTEC studied the price of corn over the last five years based on data from the NY State Agricultural Statistics. Corn prices spiked significantly in 1995 due to worldwide shortages. After interviews with the corn growers and detailed study team discussions, a corn price of $2.35 per bushel was established as the baseline price for the ethanol plant. Although this price is higher than the price offered for mid-west corn, reflecting the higher farming costs in New York, this price is lower than the five-year average corn cost derived from analysis of the agricultural statistics. This price reflects a realistic assessment of the prices that corn growers expect to receive for their crop for the foreseeable future.

1.5.2 Corn Stover

Corn Stover was identified as a primary biomass feedstock for this study. Corn stover consists of the parts left over from corn harvesting. Corn stover is a biomass feedstock that has no current economic value. Most stover is left on the farmland after corn harvesting. A large portion of this stover can be collected for producing a low-cost ethanol fuel, while the small remainder can be left on the fields as a soil-nutrient source. As the quantity of corn stover is directly related to corn production, NYSTEC developed estimates of corn stover production from data on the production of corn statewide.

1.5.3 Other Biomass

Other biomass feedstocks reviewed during this study include straw, grass, paper sludge, and dedicated feedstock (willow biomass). Production levels for these feedstocks were reviewed statewide and for the North Country Region.

Straw and grass are grown in abundant quantities in upstate New York. Grasses include timothy, broome, and oat. Straw includes barley, wheat, and oat. These feedstocks are currently used or sold as low-cost products in New York State. Some of these products are grown on land that once grew corn and other higher-value agricultural products. With the decline in demand for the higher-value products in New York, more marginal-quality lands have been converted into grass and straw farmlands. These feedstocks present options as low-cost feedstock inputs to the ethanol plant.

Paper sludge (paper-mill waste) is rich in cellulose and has a potential for ethanol production. A Wisconsin study determined that pulp and paper-mill sludges have an ethanol-yield potential of 51 to 74 gallons of ethanol per dry ton. Paper-mill wastes have traditionally been disposed of in landfills or spread on fields. Besides producing ethanol (a beneficial commodity), use of this feedstock yields the environmental benefit of saved landfill space and the economic benefit of reduced waste-disposal costs. Paper-mill waste is comprised of a number of types of waste streams. In 1993, the Pulp and Paper Industry's National Council for Air and Stream Improvement (NCASI) classified the solid-waste streams into primary sludge, secondary sludge, combined sludge, flume grit, screen rejects, wood waste, pulper rejects, lime mud, lime grit, and green liquor dregs. The sludges and the wood wastes from these processes show the most potential for conversion to ethanol. Studies have shown that primary sludge has high cellulose content. However, paper-mill wastes result from a variety of different processes and, therefore, have varying contents of ash, inorganic material, and cellulose.

Dedicated feedstock willow biomass is a new agricultural crop being researched by the State University of New York, College of Environmental Science and Forestry. Willow biomass plantations in New York are adapted from a commercially operational system in Sweden, where more than 35,000 acres of willow energy plantations have been established. Such plantations plant double rows, approximately 6,200 trees/acre, following complete site preparation, including herbicide application, plowing, and disking. Trees are planted in spring as unrooted, 10-inch-long cuttings (sticks), using planting machines developed in Sweden and modified for local conditions. Weed control, using a combination of mechanical and chemical techniques, is essential during the first year of establishment. Trees are cut after the first year to promote sprouting. Harvesting occurs every three to four years in the winter after leaves have fallen. Following each harvest, the plants re-sprout. The perennial nature of the crop means that erosion potential and pesticide application are reduced compared to more common annual agricultural crops. Willow biomass is a clean, versatile wood-energy source with potential for use as an ethanol crop.

Biomass feedstocks may provide the largest quantity and lowest-cost opportunity for large-scale ethanol-processing facilities in New York State. These alternative feedstocks may help an ethanol facility cope with the seasonality issue of corn and corn stover.

1.5.4 Processing Wastes

New York State has additional feedstock groups readily available from its food-processing industry. These alternative feedstocks could help an ethanol operation address the financial/seasonal challenges of its operation, while helping meet the environmental challenges of waste disposal. Seasonal wastes are available for short periods of time when specific crops are harvested and processed. NYSTEC surveyed food-processing and beverage industries that generate various residual solids as potential feedstock suppliers for ethanol. Table 2 lists the initial assumptions of statewide availability of food-processing wastes.

The study team evaluated wastes from the processing of many farm crops in New York State, then selected those that were the most appropriate feedstocks for ethanol production. NYSTEC initially studied agricultural processing wastes that included corn silage, brewery waste, and cheese whey; waste from processing sweet corn, cabbage, beets, snap beans, carrots, and peas; and pomace from grapes, apples, cherries and winery wastes. NYSTEC addressed the amount of crop waste that is generated based on the amount of feedstock crops that are harvested from farms in each of the three study regions.

Table 2, Statewide Food-Processing Wastes

Type of Waste	Available Quantity
Fruit Pumice	
Apples	75,000 tons
Cherries	2,000 tons
Grapes	31,000 tons
Vegetable Waste	
Snap beans	23,000 tons
Beets	33,000 tons
Cabbage	28,000 tons
Carrots	7,000 tons
Sweet Corn	75,000 tons
Peas	1,500 tons
Cheese Whey	3,200 tons
Brewery Solids	TBD

The processing wastes reviewed are most often disposed of in landfills or spread over land. Regulatory restrictions on the disposal of these wastes — as well as a shortage of space and locations for spreading wastes over land — may enable ethanol processors to purchase wastes at low prices or be compensated for removing them from the processors' plants. An estimate of processing waste composition is provided on the feedstock data sheets in Appendix A.

1.6 Available Land

New York has abundant land resources that could easily be brought into feedstock production. Increased efficiency and a contracting dairy industry in New York State have caused a decrease in cultivated acreage. For example, corn acreage in 1997 was 1.2 million acres — down from a high in the State of 1.4 million acres in 1981. In 1945, farm operators in New York owned or leased 17.6 million acres. In 1992, that figure had declined to fewer than 7.5 million acres. The 1959 Federal Census of Agriculture showed farmland (all uses) at 13,480,000 acres and cropland at 7,120,000 acres. NYS Department of Agriculture and Markets statistics indicate that, in 1997, total farmland acreage was 7,700,000 and cropland was 4,910,000. While some of this land has been developed, most remains open and available for new feedstock production.

Table 3 outlines the result of NYSTEC's analysis of available farmland in the North Country area (as well as in eighteen other upstate New York counties that could provide feedstock to an ethanol production facility or could replace feedstock that is diverted from current uses to ethanol production). Available farmland was defined as land that has reverted from farm use to natural forestation. Using data from the Census of Agriculture and a Cornell

University report, "The Return of Agricultural Lands to Forest," NYSTEC created reliable estimates of land that reverted from agricultural production between 1969 and 1997. The table is meant as a guide to land available for growing feedstock resources within the study area. This data does not account for the portion of land that is currently enrolled in federal protection programs such as the Conservation Reserve Program (CRP).

Table 3, Land Lost (acres) from Farming to Reforestation, by County, 1967 to 1997

County	Total	Active Crop-lands in 1997	Reduction 1969 to 1997	Reforested Factor	Estimated Reforested 1969 - 1997
Statewide	24,600,000	4,722,143	1,358,000	0.699	948,964
Cayuga	445,000	192,590	-1,500	0.909	-1,363
Chenango	576,667	104,034	28,600	0.953	27,257
Cortland	322,500	66,864	23,500	0.921	21,645
Fulton	320,000	21,623	7,800	0.916	7,142
Hamilton	1,090,000	n/a	n/a	0.804	n/a
Herkimer	916,667	90,171	31,600	0.826	26,088
Jefferson	827,000	193,684	66,300	0.919	60,939
Lewis	827,000	101,521	18,500	0.880	16,284
Madison	422,500	120,577	20,700	0.919	19,022
Monroe	432,500	89,730	34,000	0.530	18,007
Montgomery	260,000	104,553	13,500	0.911	12,302
Oneida	784,000	138,645	53,500	0.819	43,823
Onondaga	508,000	111,557	29,500	0.713	21,020
Ontario	417,500	153,765	24,300	0.903	21,941
Oswego	617,500	59,069	28,100	0.924	25,960
Otsego	650,000	116,366	51,700	0.922	47,645
Schoharie	400,000	70,120	28,800	0.956	27,545
Seneca	210,000	97,052	-2,200	0.908	-1,997
St. Lawrence	1,770,000	220,183	84,300	0.888	74,881
Tompkins	307,500	63,961	17,500	0.920	16,092
Wayne	387,500	125,278	37,300	0.860	32,095
Yates	220,000	77,370	8,800	0.952	8,382

The first column of the table shows the total acreage of land in each of the counties. The second column shows the total active croplands acreage in 1997, while the third column shows difference between the total acreage that was available in 1969 and that available in 1997. While all of the acreage from this third column is no longer farmed, some of that land is now developed as commercial or residential land. To account for this difference, data was scaled based upon a ratio of reforested land to total land made available. Because this ratio was not available for the selected time period (1969 to 1997), a ratio was created from development rates between 1910 and 1992. This ratio was then applied as a factor to the data on farmland reduction to create the estimated reforested acreage that is presented in the final column.

1.7 Selected Feedstocks

Utilizing the simulation provided by NREL, NYSTEC's technology subcontractor, Raytheon Engineering and Constructors, evaluated data on potential New York State feedstocks. Corn stover, hay, and straw were the most promising feedstocks and were recommended as the feedstocks for the plant. Additional testing and evaluation of these feedstocks is needed, however, to validate the assumptions made in the simulation and may include:

- A more detailed chemical analysis for modeling in the simulation,

- Further definition of ash content of the feedstocks, and
- The need to test feedstocks to verify handling characteristics.

Its large water content, which would require wastewater handling, makes corn silage impractical as a potential feedstock. Additionally, it is needed and produced to serve as a dairy feed in New York State. Sweet corn has a similar problem because it increases the wastewater flow rate an estimated 50% for a three-month period. The other feedstocks (cabbage, beets, beans, grapes, apples, carrots, peas, wine waste and cherries) were not attractive choices due to the relatively small amounts of alcohol produced and the large amounts of wastewater derived from production. Apples have an additional drawback inasmuch as the pectin content would require an increase in the pump motor horsepower. The fruits (grapes, apples, and cherries) would require pasteurization to reduce the formation of acetic acid from fermentation before being loaded for transport to the plant. Higher acetic acid content would increase the ion exchange and overliming system sizes. However, these feedstocks could become more feasible given an appropriate waste disposal credit fee structure.

Additional research is needed to determine if paper-mill residue is a favorable material and is sufficiently available in New York State for use as a feedstock. Data suggests that 263,000 tons of the 643,000 tons produced annually are used by the industrial coal stoker market and may include the lower-ash-content portions that would be the same materials needed for the ethanol plant. The high ash deinking mill stock is not desirable due to the higher ion exchange and overliming capacity requirements, and due to the higher fouling rates for the boiler burning the waste solids. Quantities of bark and woodchips would be desirable as a feedstock component.

2. Facility Description

2.1 Grain Processing Facility

Robbins Corn and Bulk Service (RCBS), located in Sackets Harbor NY, was evaluated as the existing grain-processing facility. RCBS sits on five acres and is able to process 10,000 bushels of grain a day. The facility consists of processing/grain-drying equipment, six storage structures, scales for weighing trucks, and a roaster for drying grains. RCBS is located four miles from Interstate 81, five miles from rail lines, and twelve miles from the Development Authority of the North Country Regional Solid Waste Facility.

Raytheon Engineering and Constructors, NYSTEC's architectural and engineering firm subcontractor, evaluated the RCBS operation for synergies with a biomass-to-ethanol facility. The results of Raytheon's evaluation are detailed in Appendix C, Section I (Robbins Corn and Bulk Service Evaluation, pages C5-C7).

Although efficient and effective in its operation, RCBS's size, particularly in storage capacity, is not large enough to achieve any economic synergies with a collocated biomass-to-ethanol facility. However, as noted in Section 1, sufficient feedstocks exist or could exist (via farmland put back into production) for biomass-to-ethanol processing in New York. Therefore, the limiting factor of a collocated biomass-to-ethanol facility is not in the feedstock availability, but in the insufficient size of the existing grain operation.

2.2 Process-Related Requirements

Raytheon Engineering and Constructors, based on the process-flow description provided by NREL and on the feedstock data provided by NYSTEC (see Section 1), evaluated and designed two biomass-to-ethanol plants. The two plants differ only in that one includes enzyme-production capabilities while the other assumes the required enzymes will be purchased. The specifications are contained in Appendix C, Sections II H (Conceptual Plant Layout) and II I (Process Flow Diagrams). Each of these two biomass-to-ethanol plants has a capacity of 60 million gallons per year (60 MGPY).

Raytheon Engineering and Constructors, based on direction from NYSTEC, also evaluated and designed a corn-to-ethanol plant. The specifications are contained in Appendix C, Section III F (Process Flow Diagrams). This corn-to-ethanol plant has a capacity of 30 MGPY.

2.3 Capital and Operating Costs

Raytheon Engineering and Constructors developed capital and operating costs for the island of process equipment for both plant types (biomass and corn). Capital costs are in Appendix C, Sections II E (biomass-to-ethanol plants) and III C (corn-to-ethanol plant). Operating costs are in Appendix C, Sections II F (biomass-to-ethanol plants) and III D (corn-to-ethanol plant).

2.3.1 Capital Costs

As indicated above, two differing 60-MGPY biomass-to-ethanol plant configurations were examined. The first included equipment and process for producing enzymes; the second did not include enzyme production.

In the case of the biomass plant with enzyme production, the total capital cost for the island of process equipment is $56,184,150. In the case of the biomass plant without enzyme production, the total capital cost is $51,771,150. The differential ($4,413,000) between the total capital costs of the two plants is the enzyme production capability.

In the case of the corn plant, the total island of process equipment capital cost is $15,127,000.

2.3.2 Operating Costs

The operating costs for the three plant configurations (biomass with enzyme production, biomass without enzyme production, and corn) were also derived. The operating costs include both labor and non-labor aspects.

From the labor perspective, a differential is seen based on whether the biomass plant produces enzymes or not. The biomass plant with enzyme production has an annual labor cost of $6,537,450 (including benefits), while the biomass plant without enzyme production has an annual labor cost of $6,094,650 (also including benefits). Therefore, enzyme production has a labor cost of $442,800 per annum.

Including labor costs, the operating costs for the biomass-with-enzyme-production plant total $47,232,067.

The corn-to-ethanol plant has a labor cost of $5,147,550 and a total operating cost of $54,910,292. Note that the annual operating costs of the 60-MGPY biomass plant are $7,678,225 less than the costs for the 30-MGPY corn plant. The main components of this differential are feedstock costs ($29,400,000 for the biomass plant versus $33,600,000 for the corn plant) and electricity (zero for the biomass plant versus $2,620,800 for the corn plant).

The cost comparisons for these three plant configurations are shown in Table 4.

Table 4, Capital and Operating Costs

	Biomass with Enzyme Production	Biomass without Enzyme Production	Corn
Capital	$56,184,150	$51,771,150	$15,127,000
Labor	$6,537,450	$6,094,650	$5,147,550
Operating Cost (including labor)	$47,232,067	$TBD	$54,910,292

3. Capital and Operating Cost Refinement

3.1 General Discussion

Raytheon Engineering and Constructors refined the capital and operating costs for both plant types (biomass and corn) based on site-specific criteria. Capital cost refinement, including appropriate direct and indirect costs, is detailed in Appendix C, Sections II D (biomass-to-ethanol plant) and III B (corn-to-ethanol plant). Operating costs remain the same and are detailed in Appendix C, Sections II F (biomass-to-ethanol plants) and III D (corn-to-ethanol plant).

3.2 Refinement Results

3.2.1 Capital Costs

Two differing 60-MGPY biomass-to-ethanol plant configurations were examined. The first included equipment and process for producing enzymes, and the second did not include enzyme production.

In the case of the biomass plant with enzyme production, the total capital cost for the plant is $230,344,105. This cost includes the island of process equipment and the following direct and indirect cost elements:

- Site Improvements
- Earthwork
- Concrete
- Structural Steel
- Process Equipment
- Piping
- Insulation
- Instrumentation & Controls
- Electrical
- Painting
- Buildings & Architectural
- Start-up, Testing, & Training
- Temporary Facilities
- Construction Equipment, Tools, & Supplies
- Field Staff & Legalities
- Indirect Field Cost

- Engineering (Home Office)
- Taxes
- Insurance
- Permits
- Craft Casual Overtime
- Contingency
- Construction Management Fee

In the case of the biomass plant without enzyme production, the total capital cost is $212,253,235. This cost includes the elements just listed. The total capital cost for enzyme production is the differential ($18,090,870) between the costs of these two plants.

In the case of the corn plant, the total capital cost is $70,193,000. This cost includes the elements just listed.

3.2.2 Operating Costs

The operating costs for the three plant configurations (biomass with enzyme production, biomass without enzyme production, and corn) remain as were described in Section 2.3.2. These operating costs include both labor and non-labor aspects.

Table 5 below includes Table 4 data for the island of process equipment and has been updated to reflect the addition of direct and indirect costs.

Table 5, Refined Capital and Operating Costs

	Biomass with Enzyme Production	Biomass without Enzyme Production	Corn
Capital	$56,184,150	$51,771,150	$15,127,000
Labor	$6,537,450	$6,094,650	$5,147,550
Operating Cost (including labor)	$47,232,067	$TBD	$54,910,292
Refined Capital Cost	$230,344,105	$212,253,235	$70,193,000

4. FINANCIAL PRO FORMA PREPARATION

4.1 The Model

If a project's potential capital and operating costs, product prices, and rates of return for an entire time horizon were known with certainty, an economic and financial evaluation would be easy to accomplish. Investors could determine which alternative yielded adequate rates of return, and make appropriate investment decisions. However, it is not possible to know these numbers with certainty before the plant begins operation. Ethanol production costs are particularly difficult to quantify in a pro-forma, because they rely on the purchase of feedstock(s) with fluctuating prices. The ethanol product price also fluctuates, but this fluctuation is due to other factors such as gasoline costs that are only minimally correlated with the cost fluctuations in the input parameters. Uncertainties in key variables are quite likely to create significant fluctuations in potential rates of return. Therefore, the pro-forma model used must be able to assess and comprehend the levels of change that are created by uncertainty in specific variables.

For this project, NYSTEC developed a two-step process to create a baseline pro-forma and a more detailed sensitivity analysis. Most of the financial data — including capital costs, material costs, and labor costs — was provided by Raytheon Engineering and Constructors in its report to NYSTEC (Appendix C). NYSTEC refined this pro-forma through application of a standard pro-forma format. The NYSTEC Team created a detailed baseline pro-forma using Spreadware's high-quality commercial-off-the-shelf (COTS) pro-forma software package as the basis (see Appendix D). NYSTEC developed adjustments to standardize the software package for a large ethanol-production facility. These adjustments were based on the insights NYSTEC gained during the course of the study.

It is often assumed that production and investment decisions are made with perfect knowledge about the future and are based on a desire to maximize the present value of future net revenues. Based on the expected uncertainties, the pro-forma focuses on discounted cash flow as the basis of long-term economic viability. By calculating the current dollar (discounted) value of future profits, a realistic return on investment can be determined. This return on investment must be assessed in conjunction with risk level. Larger capital investments and more experimental technology provide larger risks for investors. At this time, full-scale biomass-to-ethanol production requires both a large capital investment and a reliance on technology that has not been proven at a full production scale.

The anticipated New York State ethanol industry has one element that is not captured in the discounted cash-flow and risk-assessment data within a standard pro-forma. A large ethanol industry will have a positive net effect on the depressed rural NYS economy. This is likely to provide further encouragement for participation in a farmer-owned ethanol-production operation. Additional profits will revert back to farmer investors through the development of a more stable overall farm economy. These advantages are not quantified in this model, but they would likely accrue to any farmer-investor group, and to the farm community as a whole, should an ethanol plant be built. The advantages that this industry may provide to State government are quantified and discussed in the sensitivity analysis section (Section 5).

4.2 Pro-Forma Design

The baseline pro-forma outlines one cost scenario for developing a biomass-to-ethanol production plant with enzyme production at RCBS. The objective of the pro-forma is to estimate operating costs based on the best data available.

All costs contained in the attached pro-forma pages (capital costs, materials, labor, taxes, revenue, and transportation) are in 1999 dollars as NYSTEC believes that inflation will effect all these areas equally. By estimating costs based on a single-year dollar value, we were able to provide straight-line estimates of income and operating expenses. Although a series of technical and political issues can be expected to impact the cost of ethanol and the cost of inputs to the process, these will be reviewed in the Sensitivity Analysis phase of the project. The debt service page and the income statement are provided with charts in two separate formats. One format is in baseline year (1999) dollars, while the other is in actual-year dollars based upon an annual 3% inflation rate.

The first two years of the financial pro-forma are considered to be construction years. The plant is estimated to have an 18-month construction and ramp-up phase with periodic testing and shutdowns. During the following six months, some testing and tuning will be required before the plant reaches full capacity. By 'Operation Year 1,' the third year in the pro-forma, it is assumed that the plant is running at full capacity.

4.3 Analysis of Pro-Forma Components and Inputs

The complete baseline financial pro-forma is provided in Appendix D. Project costs in the pro-forma are detailed by category and outlined in the sections that follow.

4.3.1 Capital and Site Review

The first page of the pro-forma reviews the up-front costs as outlined by Raytheon Engineering and Constructors. The total capital and site costs are provided as the input to the debt and depreciation calculations in the next page. Direct field costs for construction of the 60-million-gallon-per-year biomass-to-ethanol facility total $159.3 million. This cost includes construction equipment, tools, supplies, and temporary facilities.

Additional field costs of $4.7 million are incurred to cover field staff and legalities. Start-up and testing are not included in these costs, but are covered through calculation of the losses of product for sale within the two construction years. Engineering costs total $13.9 million and overtime, permits, and insurance add an additional $1.6 million. Taxes are assumed to be waived for the purchase of construction materials and equipment, as is the standard for most large industrial job-creation projects. A contingency has been planned equal to 25.9% of total field and home office costs. It is assumed that the contingency covers minor items not included in the equipment list, unknown equipment requirements, unknown site requirements, and other unidentified costs. It is also assumed that the contingency will cover all on-site costs.

The estimate does not include the cost of offsite roads, railroads, and utility connections. Such off-site costs are assumed to be covered by the appropriate utility, agency, or railroad that would benefit from the economic impact of providing these upgrades. With the inclusion of a $4.8 million construction management fee, the total capital cost comes to $230.3 million.

4.3.2 Debt Schedule

The second page of the pro-forma shows the debt-repayment estimates. The debt includes an additional 10% of construction costs for working capital. For the base case, we assume that there is no up-front capital. Although most similar plant construction would include up to 30% up-front equity, these funds would not be available by an entity to build this plant in New York at this time. Other debt-to-equity ratios are reviewed in the sensitivity analysis.

The debt payments are based on a 15-year loan at an interest rate of 11%. Rates and terms were based on estimates by Raytheon Engineering and Constructors. Long-term debt is calculated and summarized in actual-year dollars. At the bottom of the debt-schedule page, these numbers are converted into 1999 dollars. Debt levels during the construction years are based upon the level of completion of plant construction and equipment orders. During the first construction year, only the loan fees will be collected, as outlined in the Generally Accepted Accounting Principles (GAAP).

The plant depreciation is provided on a straight-line basis over 20 years, based upon the standards of the GAAP. Start-up expenses are estimated to be in the range of $1.4 million and are amortized over the five years beginning in the start-up year, as per GAAP.

4.3.3 Materials

Raytheon Engineering and Constructors provided estimated material costs as outlined on the third page of the pro-forma. For the baseline case, it is assumed that material costs will remain constant, excluding inflationary effects. The delivered cost of biomass is estimated at $35 on average. This page also includes all operating chemical, process water, natural gas, disposal costs, maintenance materials, and miscellaneous incidentals. Although the plant will not produce product at 50% of capacity in the second construction year, it is assumed that 50% of supplies and feedstock will be required. This accounts for the inevitable bad batches, start-up challenges, and ramp-up situation that must be accounted for within this year.

4.3.4 Labor

Based on the estimates provided by Raytheon Engineering and Constructors, the plant will require 97 production employees and 7 administrative employees. Labor and fringe rates were provided by Raytheon Engineering and Constructors. Production employees average $50,103 per year and administrative employees average $65,000 per year. All employees require an employer contribution to benefits that is equal to an additional 23% of salary. These values are based on similar operations elsewhere. It is assumed that labor costs will run at 44% of full costs during the hiring and ramp-up period in the second construction year.

4.3.5 Tax Impacts

The fifth page of the pro-forma is provided to analyze federal, State, and local tax costs as well as State and local government incentives. For this baseline, we included a rate of 35% of revenues as a federal tax. Because federal taxes are not due until all losses from previous years of operation are written off, there are no federal taxes until the cumulative total bottom line from plant operations becomes positive. This does not occur until the twentieth year of operation.

State and local taxes are assumed to be offset over the first ten years by any State and local incentives provided. Property taxes are assumed to be waived for the first five years and to be reduced to $9000 in subsequent years. This is based on the average type of incentives provided by the State of New York. The effect of additional incentives will be reviewed in more detail in the sensitivity analysis phase of this project.

State benefits are realized and incentives granted through the assessment of potential new tax revenue from job creation. NYSTEC collected data on these effects from the Public Policy Institute of New York, and provided some preliminary data based upon the direct plant jobs and their induced multiplier effects. These effects are quantified on the tax impacts page. Additional detail, including estimates of indirect non-farm jobs and their induced multiplier effects, will be discussed in the sensitivity analysis section of this report.

4.3.6 Revenue Forecast

The sixth page of the pro-forma identifies the proposed sale price of products. It is assumed that this process will not produce any co-products for on-farm sales, but will provide a co-product that can be burned for use in producing electricity for on-site and off-site use. CO_2 produced by the process will be sold at an estimated price of $7 per ton. Electricity sale prices are based on estimates from Niagara Mohawk Power Corporation. CO_2 prices are based on averages provided by Gaylord Engineering. The ethanol sale price was set at $1.15 per gallon at the plant gate. This price does not account for product transportation costs.

4.3.7 Income Statement

The seventh page of the pro-forma ties together the figures from the other pages and presents a total picture of the financial status of the facility. This is done through five separate types of analysis. First, this page provides a summary, in baseline 1999 dollars, of the income and expenses from each previous page. Second, using the 3% annual inflation rate, the income and expenses are reviewed in the actual-dollar values that they are predicted to be in any given year. Third, a review of the value of capital equipment through depreciation is provided. Fourth, an analysis shows the net present value of profit and capital investments. This analysis allows financial supporters to review the return on investment. This baseline plant requires an initial investment of $253.4 million to cover capital costs and working capital during construction and sees a return of $604,074 in present value dollars at the end of the twentieth year. This is not a reasonable return for this size of an investment, for it provides barely 0.3% return over the rate of inflation. Fifth and final, expenses are broken down to show their cost per gallon of denatured ethanol in the first full-scale year of production.

4.3.8 Summary of Transportation Costs

The final page of the pro-forma outlines the costs to transport feedstock from the farm to the plant, and finished product from the plant to the consumer. This is not a standard pro-forma page, and therefore is provided as an addendum to the pro-forma for informational purposes only. Trucking costs from the farm to the plant are estimated at $7.35 per ton, based on local costs charged for 35-mile transportation of farm goods. This is based upon 35 miles being the average transportation distance from any point within 50 miles of the plant to the actual plant site. Rail costs from the plant to the consumer are estimated at 4.5 cents per gallon, based on the cost of tank car lease and transportation cost estimates provided by the Mohawk, Adirondack and Northern Railroad for transport from upstate New York to the greater New York City area. Costs to transport feedstock have been included in the feedstock costs.

4.4 Conclusions from the Baseline Pro-Forma

In the first full year of production, the ethanol plant sees a total loss of $19.1 million. The plant starts reporting yearly income beginning in Year 10, and sees a significant jump in income with the completion of the depreciation schedule in Year 20. By Year 20, the plant has an annual income of $38.6 million. At the end of ten years, the present value of all losses totals over $118.1 million. In Year 20, the plant offsets all losses and pays federal tax for the first time. At the end of this twentieth year, the present value of all profits is just over $600,000.

Although a small profit is shown over the 20 years, it does not justify the large up-front capital investment. This can clearly be determined from the Net Present Value Analysis on the Income Statement page of the pro-forma. The baseline plant requires an initial investment of $253.4 million to cover capital costs and working capital during construction and sees a return of $604,074 in present value dollars at the end of the twentieth year. This provides a return-on-investment after 20 years that is barely 0.3% over the annual effects of inflation. Therefore, this baseline scenario will be unable to secure investments for constructing the plant.

5. SENSITIVITY ANALYSIS

5.1 Introduction

NYSTEC developed the pro-forma profile of the capital, operating, sales, and profit figures from the ethanol facilities. Because of the unique nature of a large number of parameters that drive the ethanol industry — parameters that include feedstock cost, ethanol price and co-product prices — the sensitivity analysis was developed to more carefully assess the risk and return-on-investment opportunities that are available for a biomass-to-ethanol processing plant.

NYSTEC used the Agricultural Systems Economic Evaluation Development (ASEED) model to analyze the effect of price fluctuations in capital costs, debt costs, transportation, labor, and feedstock costs on the feasibility of ethanol production. Detailed analyses were conducted in nineteen different areas. In many of these areas, a number of deviations from the baseline were assessed.

The results of all sensitivity analysis steps are summarized in Table 6 (on the following page). This table outlines each scenario, the action taken to change the baseline cost, and the effect on various key cost elements in the pro-forma. These cost elements include, profit in year 1, profit in year 10, profit in year 20, construction cost, total debt (calculated as construction cost plus contingency minus up-front equity), present value return-on-investment at year 10, and present value return-on-investment at year 20. Because this pro-forma is developed to address the many complicated cost elements that are required for financial feasibility, some results may appear to be counter-intuitive. For example, some cases that would be likely to increase overall profitability (for example: Case 09a, reduced landfill costs) result in a reduction in profit in the twentieth year. (In the cited case, the peculiar result is due to the earlier break-even point of the more profitable operation.) While the base case only begins to assess federal taxes in the twentieth year, a case that becomes profitable earlier will require full federal tax payments before the twentieth year.

The scenarios and results from Table 6 are explained in more detail in the sections below.

5.2 Sensitivity Analysis Results

5.2.1 On-Site Costs

Estimated potential on-site costs at Sackets Harbor could add to project cost. Although Raytheon included contingency costs to cover most on-site expenses, these contingencies did not include the cost of running new rail, power, and water lines to the site. If these are not covered as part of an economic-development benefit, they could add up to $3 million on top of the current construction cost estimate. The effect of that additional $3 million cost was assessed.

This added cost — additional principal plus interest from the $3 million up-front expense — would result in a reduction of $5.1 million in total return on investment.

5.2.2 Start-up Problems

Estimated costs of unforeseen start-up problems that have not been quantified in the engineering cost estimates could also negatively impact the project. Start-up problems are

Table 6, Sensitivity Analysis Results (Effect on 60 MGY Biomass to Ethanol Plant)								
Scenario	Change Created by Scenario	Year 1 First Full Scale Year Profit	Year 10 Profit	Year 20 Profit	Construction Cost	Total Debt	Ten Year Present Value Profit	Twenty Year Present Value Profit
BASELINE SCENARIO		($19,075,236)	$607,932	$38,621,622	$230,344,105	$253,378,516	($118,199,159)	$604,074
01a. On Site Cost Problems	Increase On-Site Construction Costs by $3 million	($19,588,236)	$244,372	$39,319,452	$233,344,105	$256,678,516	($122,324,953)	($4,446,292)
Change from Baseline ------------->		($513,000)	($363,560)	$697,830	$3,000,000	$3,300,000	($4,125,794)	($5,050,366)
02a. Start Up Problems	Reduce Const. Year 2 Ethanol Sales by $3.4 million	($19,075,236)	$607,932	$39,319,452	$230,344,105	$253,378,516	($121,599,159)	($2,397,963)
Change from Baseline ------------->		$0	$0	$697,830	$0	$0	($3,400,000)	($3,002,037)
03a. Extra Permit Costs	Add $250,000 to the cost of construction permitting	($19,117,986)	$577,636	$38,900,270	$230,594,105	$253,653,516	($118,542,975)	$308,956
Change from Baseline ------------->		($42,750)	($30,297)	$278,649	$250,000	$275,000	($343,816)	($295,118)
04a. Five percent interest rate above inflation	Reduce interest rate to 5%	($11,337,987)	$6,193,534	$25,552,120	$230,344,105	$253,378,516	($52,090,118)	$51,583,678
Change from Baseline ------------->		$7,737,249	$5,585,602	($13,069,501)	$0	$0	$66,109,041	$50,979,604
04b. Zero percent interest rate above inflation	Reduce interest rate to 0%	$1,557,429	$9,042,875	$25,552,120	$230,344,105	$253,378,516	$32,746,320	$128,785,224
Change from Baseline ------------->		$20,632,665	$8,434,943	($13,069,501)	$0	$0	$150,945,479	$128,181,150
05a. 9:1 Debt to Equity Ratio	Include 10% up-front equity in the plant	($16,541,451)	$2,098,611	$25,552,120	$230,344,105	$253,378,516	($99,646,842)	$14,602,338
Change from Baseline ------------->		$2,533,785	$1,490,678	($13,069,501)	$0	$0	$18,552,317	$13,998,264
05b. 2.33:1 Debt to Equity Ratio	Include 30% up-front equity in the plant	($11,473,881)	$5,079,968	$25,552,120	$230,344,105	$253,378,516	($62,542,208)	$42,598,867
Change from Baseline ------------->		$7,601,355	$4,472,035	($13,069,501)	$0	$0	$55,656,950	$41,994,793
06a. Five year depreciation	Depreciate plant consturction costs over 5 years	($55,121,685)	$12,623,415	$39,319,452	$230,344,105	$253,378,516	($232,686,724)	($41,784,285)
Change from Baseline ------------->		($36,046,449)	$12,015,483	$697,830	$0	$0	($114,487,565)	($42,388,359)
06b. Ten year depreciation	Depreciate plant construction costs over 10 years	($31,090,719)	$12,623,415	$39,319,452	$230,344,105	$253,378,516	($217,366,250)	($26,463,811)
Change from Baseline ------------->		($12,015,483)	$12,015,483	$697,830	$0	$0	($99,167,091)	($27,067,885)
06c. Twenty-five year depreciation	Depreciate plant construction costs over 25 years	($16,672,140)	$3,011,029	$19,304,069	$230,344,105	$253,378,516	($94,682,194)	$21,648,087
Change from Baseline ------------->		$2,403,097	$2,403,097	($19,317,553)	$0	$0	$23,516,965	$21,044,013

Scenario	Change Created by Scenario	Year 1 First Full Scale Year Profit	Year 10 Profit	Year 20 Profit	Construction Cost	Total Debt	Ten Year Present Value Profit	Twenty Year Present Value Profit
07a. Competative Feedstock Market	Feedstock costs raised to $50 per ton	($31,675,236)	($15,832,210)	$17,225,276	$230,344,105	$253,378,516	($250,499,159)	($257,297,963)
Change from Baseline ------------>		($12,600,000)	($16,440,142)	($21,396,346)	$0	$0	($132,300,000)	($257,902,037)
07b. Use of hay feedstock	Feedstock costs raised to $100 per ton	($73,675,236)	($70,632,684)	($56,421,979)	$230,344,105	$253,378,516	($691,499,159)	($1,118,297,963)
Change from Baseline ------------>		($54,600,000)	($71,240,616)	($95,043,600)	$0	$0	($573,300,000)	($1,118,902,037)
07c. Use of corn and stover together	Feedstock costs raised to $59 per ton	($39,235,236)	($25,696,295)	$3,968,770	$230,344,105	$253,378,516	($329,879,159)	($412,277,963)
Change from Baseline ------------>		($20,160,000)	($26,304,227)	($34,652,852)	$0	$0	($211,680,000)	($412,882,037)
07d. Use of biomass and paper mill waste	Feedstock costs lowered to $18 per ton	($4,795,236)	$12,501,951	$41,828,163	$230,344,105	$253,378,516	$20,615,797	$190,885,074
Change from Baseline ------------>		$14,280,000	$11,894,018	$3,206,542	$0	$0	$138,814,956	$190,281,000
07e. Use of DFSS woody biomass	Feedstock costs raised to $75 per ton	($52,675,236)	($43,232,447)	($19,598,352)	$230,344,105	$253,378,516	($470,999,159)	($687,797,963)
Change from Baseline ------------>		($33,600,000)	($43,840,379)	($58,219,973)	$0	$0	($352,800,000)	($688,402,037)
08a. Cellulose bought from outside producer	Adjust lower construction cost, labor cost, and add new material cost	($45,263,683)	($35,406,042)	($12,026,687)	$212,253,235	$233,478,559	($400,809,854)	($566,453,245)
Change from Baseline ------------>		($26,188,447)	($36,013,975)	($50,648,309)	($18,090,870)	($19,899,957)	($282,610,695)	($567,057,319)
09a. Landspread wastes	Landfill costs reduced from approx. $300k to $0	($18,761,496)	$1,017,292	$35,224,476	$230,344,105	$253,378,516	($114,904,889)	$4,784,659
Change from Baseline ------------>		$313,740	$409,360	($3,397,145)	$0	$0	$3,294,270	$4,180,586
10a. Labor costs lower	Labor costs lowered 10% across the board	($18,421,491)	$1,460,921	$31,567,010	$230,344,105	$253,378,516	($111,374,061)	$9,289,729
Change from Baseline ------------>		$653,745	$852,989	($7,054,612)	$0	$0	$6,825,097	$8,685,656
10b. Labor costs significantly lower	Labor costs lowered 30% across the board	($17,114,001)	$3,166,899	$27,787,494	$230,344,105	$253,378,516	($97,723,866)	$26,661,041
Change from Baseline ------------>		$1,961,235	$2,558,967	($10,834,127)	$0	$0	$20,475,292	$26,056,967
11a. Lower Oil Prices by approx. 20%	Lower truck and rail costs, ethanol sale price and feedstock price	($25,739,436)	($8,087,337)	$27,633,737	$230,344,105	$253,378,516	($187,580,562)	($135,021,367)
Change from Baseline ------------>		($6,664,200)	($8,695,269)	($10,987,885)	$0	$0	($69,381,404)	($135,625,441)
11b. Higher Oil Prices by approx. 20%	Raise truck and rail costs, ethanol sale price and feedstock price	($12,394,836)	$9,324,339	$33,166,299	$230,344,105	$253,378,516	($48,649,032)	$89,234,256
Change from Baseline ------------>		$6,680,400	$8,716,407	($5,455,322)	$0	$0	$69,550,126	$88,630,182
12a. Truck transport cost increase	Increase truck transportation (and feedstock) cost by 7%	($19,507,416)	$44,035	$38,561,622	$230,344,105	$253,378,516	($122,737,049)	($7,857,653)
Change from Baseline ------------>		($432,180)	($563,897)	($60,000)	$0	$0	($4,537,890)	($8,461,727)
12b. Truck transport cost decrease	Increase truck transportation (and feedstock) cost by 7%	($18,643,056)	$1,171,829	$33,942,020	$230,344,105	$253,378,516	($113,661,269)	$6,362,872
Change from Baseline ------------>		$432,180	$563,897	($4,679,602)	$0	$0	$4,537,890	$5,758,799

Scenario	Change Created by Scenario	Year 1 First Full Scale Year Profit	Year 10 Profit	Year 20 Profit	Construction Cost	Total Debt	Ten Year Present Value Profit	Twenty Year Present Value Profit
13a. Rail transport cost increase	Increase rail costs 7% and adjust feedstock sale price accordingly	($19,264,236)	$361,330	$38,988,039	$230,344,105	$253,378,516	($120,167,594)	($2,856,398)
Change from Baseline ------------>		($189,000)	($246,602)	$366,418	$0	$0	($1,968,435)	($3,460,472)
13b. Rail transport cost decrease	Decrease rail costs 7% and adjust feedstock sale price accordingly	($18,886,236)	$854,534	$36,585,008	$230,344,105	$253,378,516	($116,230,724)	$3,112,057
Change from Baseline ------------>		$189,000	$246,602	($2,036,614)	$0	$0	$1,968,435	$2,507,983
14a. Federal tax incentives reduce rate to 25%	Reduce federal tax rate to 25%	($19,075,236)	$607,932	$38,821,002	$230,344,105	$253,378,516	($118,199,159)	$717,778
Change from Baseline ------------>		$0	$0	$199,380	$0	$0	$0	$113,704
14b. State and Fed rates reduce effective Fed tax to 0%	Reduce federal tax rate to 0%	($19,075,236)	$607,932	$39,319,452	$230,344,105	$253,378,516	($118,199,159)	$1,002,037
Change from Baseline ------------>		$0	$0	$697,830	$0	$0	$0	$397,963
15a. State taxes all reduced to zero	Reduce all state taxes to zero	($19,075,236)	$619,675	$38,637,403	$230,344,105	$253,378,516	($118,154,159)	$739,074
Change from Baseline ------------>		$0	$11,743	$15,782	$0	$0	$45,000	$135,000
15b. Proprety taxes due all years at $9000	Include property taxes for all years at $9000	($19,084,236)	$607,932	$38,621,622	$230,344,105	$253,378,516	($118,262,159)	$541,074
Change from Baseline ------------>		($9,000)	$0	$0	$0	$0	($63,000)	($63,000)
15c. Full State Property and Income Taxes	Include property taxes at $12,000 and state tax at 5%	($20,907,407)	($685,927)	$39,314,191	$240,988,375	$265,087,213	($132,936,847)	($18,458,125)
Change from Baseline ------------>		($1,832,170)	($1,293,859)	$692,570	$10,644,270	$11,708,697	($14,737,688)	($19,062,199)
16a. State Producer Credit - 15 cents per gallon	15 cent per gallon producer credit through year 5, phase out to year 8	($10,075,236)	$607,932	$25,552,120	$230,344,105	$253,378,516	($60,464,159)	$38,131,824
Change from Baseline ------------>		$9,000,000	$0	($13,069,501)	$0	$0	$57,735,000	$37,527,750
17a. Higher product demand	Increase ethanol sale price by 15%	($8,725,236)	$14,112,335	$37,348,832	$230,344,105	$253,378,516	($10,403,909)	$137,945,986
Change from Baseline ------------>		$10,350,000	$13,504,402	($1,272,789)	$0	$0	$107,795,250	$137,341,913
17b. Higher product supply	Reduce ethanol sale price by 15%	($29,425,236)	($12,896,470)	$21,170,664	$230,344,105	$253,378,516	($225,994,409)	($210,293,213)
Change from Baseline ------------>		($10,350,000)	($13,504,402)	($17,450,957)	$0	$0	($107,795,250)	($210,897,287)
18a. No market for carbon dioxide	Reduce carbon dioxide sale price to $0	($19,944,006)	($525,615)	$37,796,058	$230,344,105	$253,378,516	($127,247,398)	($16,733,903)
Change from Baseline ------------>		($868,770)	($1,133,548)	($825,563)	$0	$0	($9,048,240)	($17,337,977)
18b. Higher market for carbon dioxide	Increase carbon dioxide sale price from $7 per ton to $9 per ton	($18,827,016)	$931,803	$35,946,869	$230,344,105	$253,378,516	($115,613,947)	$3,897,891
Change from Baseline ------------>		$248,220	$323,871	($2,674,752)	$0	$0	$2,585,211	$3,293,817
18c. Much higher market for carbon dioxide	Increase carbon dioxide sale price from $7 per ton to $11 per ton	($18,578,796)	$1,255,674	$33,272,117	$230,344,105	$253,378,516	($113,028,736)	$7,191,709
Change from Baseline ------------>		$496,440	$647,742	($5,349,505)	$0	$0	$5,170,423	$6,587,635
19a. Higher electric costs	Increase sale price of electricity by plant by 35%	($17,744,534)	$2,344,198	$27,068,827	$230,344,105	$253,378,516	($104,339,889)	$18,262,167
Change from Baseline ------------>		$1,330,703	$1,736,265	($11,552,794)	$0	$0	$13,859,270	$17,658,093
19b. Lower electric costs	Decrease sale price of electricity by plant by 35%	($20,405,939)	($1,128,333)	$36,986,056	$230,344,105	$253,378,516	($132,058,428)	($26,164,261)
Change from Baseline ------------>		($1,330,703)	($1,736,265)	($1,635,565)	$0	$0	($13,859,270)	($26,768,335)

unlikely, but, with an unproven technology, they may cause a late start or unforeseen shut downs within the first two months. This would cause a loss of revenue within the first two months (assuming 50% downtime) that could add $3.4 million to the current cost of construction.

The effect of this $3.4 million start-up expense would be a $3.0 million total reduction in return on investment. This scenario has a lower impact than the increased on-site costs, because start-up costs are all attributed to the second construction year, rather than rolled into increased loan costs.

5.2.3 Environmental Permitting

Some New York sites require complicated environmental permitting. This has not been reviewed for the Sackets Harbor site. Therefore, cost of environmental permitting and regulation could add $250,000 to project construction and start-up costs.

The effect of this additional permitting cost rolled into the construction loan be a $295,000 reduction in return on investment over 20 years.

5.2.4 Variation of Interest Rates

Interest rates for this program are based on a few assumptions. They are based on the assumption that the initial investments for capital expenses would be obtained under standard loans from banks and/or investors, and that they would expect a fixed rate over a ten-year period from the plant. The current case is based on Raytheon's estimate of an 11% interest rate. There are a few situations that could result in lower interest rates. If the loans were to be guaranteed by the State or federal government, they could be provided by a bank at a level closer to 8%. A loan with a significant government subsidy or support could be provided for as low as the rate of inflation (assumed to be 3% for this study).

While loan programs may move the risk of plant problems from the investor to the government, the result is that plant profitability for this baseline case becomes immediately more feasible. This is because loan guarantees have a significant effect on the profitability of the facility. With an interest rate set at 8%, the facility shows a return on investment of $51.6 million. The facility shows a profit in year 8. With a 3% interest rate the facility shows a profit in Year 1, and pays off all construction year expenses and starts providing a return to investors by year 5. Total return on investment is $128.7 million.

5.2.5 Debt-Equity Ratios

Investor-owned plants could use investor dollars for funding the program. The current pro-forma assumes no base equity from the participant investors. The establishment of a 9:1 or a 2.33:1 debt-to-equity ratio was reviewed. The first case would require 10% up-front financing, totaling $23.0 million, while the second case would require 30% up-front financing, totaling $69.1 million. Unless a major corporation were to take an interest in the ethanol plant, it is unlikely that funds in these ranges could be secured.

In the first case, the plant will see a total twenty-year return on investment of $14.6 million; while in the second case, the plant will see a total twenty-year return on investment of $42.6 million. Despite bringing in larger profits, these numbers are unlikely to cause a participant to invest up-front equity that exceeds the full twenty-year return on investment.

5.2.6 Depreciation Levels

A well-designed ethanol plant will last for a number of years beyond the initial depreciation timeframe for the capital equipment. This allows the plant to make significant profits after the completion of depreciation, or to put funds into the upkeep and expansion of the plant beyond the depreciation years. Nonetheless, investors are mainly concerned with the return in the first five, ten, or twenty years, when full depreciation is being attributed to the plant. GAAP suggests depreciation based upon a straight-line rate over the life of the plant, usually over twenty years. Variations of depreciation curves for longer or shorter plant lifetimes will be assessed, including ten, fifteen, and twenty-five years. Unfortunately, it is unlikely that investors would allow deviation from the twenty-year straight-line depreciation system.

Shorter depreciation timeframes make the plant less profitable by the tenth or twentieth year. With a ten-year depreciation curve, the plant loses an additional $99.2 million from the baseline when reviewed based upon ten-year return on investment. By year 20, that difference is not yet overcome, as the twenty-year return on investment is still $27.1 million lower than the baseline. A five-year depreciation creates an even worse financial picture, with a twenty-year return on investment that is $42.4 million below the baseline. When depreciation is extended to twenty-five years, there is an improvement in return-on-investment, resulting in a savings of $21.0 million over the first twenty years.

5.2.7 Feedstock Costs

Annual cost of biomass feedstock is assumed to be $35 per ton, based on the cost of collecting and transporting corn stover while providing some profit to farmers who participate. NYSTEC also assessed the effects on this baseline pro-forma that occurred when feedstocks were available at different costs. Costs that were reviewed include the cost of biomass in a more competitive market ($50 per ton), the cost of dedicated energy-farm feedstock supplies in the long term ($75 per ton), the current cost of hay ($100 per ton), the rates for a similarly designed plant that could use a 50/50% mix of corn stover and corn (at $59 per ton), and the use of a 50/50% biomass and paper mill waste mix (at $18 per ton).

Feedstock costs have a significant effect on the profitability, return on investment, and feasibility of the entire biomass-to-ethanol processing industry. At the baseline cost of $35 per ton, the plant shows a twenty-year return on investment of $0.6 million. At other biomass costs, the returns are as follows:

- At $50 per ton, the return over 20 years is a negative $257.3 million
- At $59 per ton, the return over 20 years is a negative $412.3 million
- At $75 per ton, the return over 20 years is a negative $687.8 million
- At $100 per ton, the return over 20 years is a negative $1,118.3 million
- At $18 per ton, the return over 20 years is $190.9 million

Therefore, it is clear that the cost per ton of biomass is a major deciding factor in the ability to secure future profitability of a biomass-to-ethanol processing facility. Although the current facility would still not secure investors in the base case with biomass guaranteed at $18 per ton, there is a future potential for the return on investment at this low biomass cost to be feasible.

But, at the current cost of New York hay ($100 per ton), over a billion dollars in losses would need to be overcome in order to create a profitable biomass processing plant. This is unlikely to ever occur. At this time, farmers are providing a variety of responses on the potential purchase price for corn stover and other biomass feedstocks. Although we are comfortable that the baseline price of $35 is realistic, more detailed analysis of the potential cost for biomass feedstocks would be necessary before any investor would be willing to make the commitment to a processing facility.

5.2.8 Cost of Enzymes

Raytheon Engineering and Constructors developed construction-cost estimates and some operating-cost estimates based upon two scenarios. One scenario provides for in-house cellulase enzyme production, while the other scenario provides for enzyme purchase from a vendor. Raytheon Engineering and Constructors recommended in-house production despite the larger up-front capital cost. For this step in the sensitivity analysis, NYSTEC reviewed the case with off-site enzyme production.

This case saves $18.1 million in up-front construction costs and $19.9 million in total debt, including construction cost and working capital. There are additional savings in labor costs. But, NYSTEC's best estimate suggests that the twenty-year return on investment would be more than $500 million lower if enzymes were being purchased from off-site at a rate that Raytheon Engineering and Constructors set at $150 per pound. Because cellulase costs are only estimates provided by Raytheon Engineering and Constructors, and cellulase quantities are only estimates provided by NYSTEC, we cannot be completely confident that this would be the exact magnitude of lost return. But, it is clear that the additional construction cost for cellulase production creates more certainty as well as more profit in the baseline pro-forma.

5.2.9 Land-spread Wastes

The current pro-forma estimates that wastes will be landfilled at a cost of over $300,000 per year. Raytheon Engineering and Constructors has indicated that, with proper permits, these wastes might be land spread at no cost. The effect on profit of this option was assessed.

This scenario results in an additional twenty-year return on investment of $4.2 million.

5.2.10 Cost of Labor

Raytheon Engineering and Constructors indicated that it estimated labor rates based on similar operations elsewhere. Based upon the rates for similar industrial operations in the North Country area, there was some feeling that the baseline estimates provided by Raytheon Engineering and Constructors might be high. Those estimates are approximately 58% higher than the labor rates that NYSTEC has used in a similar corn-to-ethanol study. The effects of a 10% and a 30% reduction in labor costs were assessed. The first case brought average production salaries down to $45,093, and average administrative salaries down to $58,500. The second case brought average production salaries down to $35,072, and average administrative salaries down to $45,500.

The result of these two cases shows the linear relationship between labor rates and return-on-investment over twenty years. Each one-percent reduction in labor rates results in a twenty-year increase in return of $869,000. A ten-percent reduction creates an additional $8.7 million, while a thirty-percent reduction results in a $26.1 million additional return.

5.2.11 Oil Prices

Variations in oil prices will effect the price of ethanol, the cost of feedstocks, and the cost of transportation for feedstocks and finished products. It would also have the effect of adjusting the sale price of ethanol to account for its reliance on the price of gasoline. The effects of a 20% increase and a 20% decrease in oil costs were assessed, along with the effects that these changes would have on the cost of ethanol, feedstock, and transportation.

A 20% increase in oil costs would raise the pre-tax profits in a given year by $6.6 million (in 1999 dollars), while a 20% decrease in oil costs would reduce the pre-tax profits by a similar amount. The net positive impact of oil cost increases would overcome any negative impacts in transportation and feedstock costs. Over the course of twenty years, a twenty-percent oil cost increase could result in an additional $88.6 million in return-on-investment. But, short of some significant policy change or political upheaval, it is unlikely that oil costs would rise 20% and stay there over the 20-year pro-forma period. A more likely scenario would have oil costs fluctuating within a range that is close to or just above current costs. But, plant investors should be aware that a $6.6 million yearly impact could result in from a twenty-percent cost change.

5.2.12 Cost of Truck Transportation

The effect of a 7% change in truck transport cost was assessed: it would raise or lower feedstock costs by 51 cents per ton.

As would be expected, the effect of this is similar to the effect of having higher or lower feedstock prices in general. In the first year, it impacts profitability by $432,000. Over twenty years, the increased truck costs would reduce return on investment by $8.5 million while the decreased truck costs would improve return on investment by $5.6 million. Because it is likely that trucking costs will fluctuate from year to year, it is unlikely that the entire transportation cost impact would be reflected for the full twenty-year pro-forma time frame. Instead, investors need to be aware that a 7% trucking rate change would create a yearly adjustment in pre-tax profit of $432,000 (in 1999 dollars).

5.2.13 Cost of Rail Transportation

The effect of a 7% change in rail transport cost was assessed. NYSTEC thought this assessment was necessary because of the potential impact on prices that could occur with rail mergers. It is also likely that, if the biomass plant contracts directly with CSX, rather than with a local short-line railroad, prices may be higher than estimated. The cost of transporting ethanol does not directly effect the pro-forma and the plant economics. But, it is assumed that the refiner or blender will be unwilling to pay the same price for ethanol if rail costs are higher. It is also assumed that the refiner or blender would be willing to pay more for ethanol at the plant gate if the cost to transport that ethanol were lower. A 7% rate change has a 0.315 cent per gallon effect on the price of ethanol.

The result of this rail-cost adjustment is smaller than that of a similar change in the cost of truck transportation. In the first year, it impacts profitability by $189,000. Over twenty years, the increased rail costs would reduce return on investment by $3.5 million, while the decreased rail costs would improve return on investment by $2.5 million. Because it is likely that rail costs will fluctuate from year to year (although there is a general trend toward rate reduction in the long term), it is unlikely that the entire transportation cost impact would be reflected for the full twenty-year pro-forma time frame. Instead, investors need to be aware that a 7% rail rate change could create a yearly adjustment in pre-tax profit of $189,000 (in 1999 dollars).

5.2.14 Federal Tax Rates

The baseline assumes a federal tax rate of 35%. This is formed on the basis of an assumption that the facility will be set up as a limited partnership. Therefore, no taxes are charged directly to the partnership, but corporate income taxes at a corporate rate would be due to the partners after the operation starts turning a profit and pays off all losses. Net income may be different if federal taxes are incurred at lower rates. Therefore, the effects of different corporate structures and incentives with tax rates at 25% and 0% were assessed.

The effect of this change on the baseline pro-forma is minimal. It is expected that if the operation were to offset losses earlier, a reduction in federal tax rates would have an impact. But, in the base case, the plant is writing off losses through year 19. Therefore, no federal tax is due, regardless of the rate. If the rate is changed to 25%, a benefit of $199,380 accrues in year 20 ($113,704 in 1999 dollars). At a 0% federal tax rate, the benefit in year 20 is $697,830 ($397,963 in 1999 dollars).

5.2.15 State Tax Rates

The base case assumption is that a State and local set of basic tax incentives are in place. This includes a full property tax exemption for the first five years and a partial (25%) property tax exemption for the remainder of the plant lifetime. State income taxes are set at zero. Also, no sales tax is due on construction equipment. The effect of a full waiver of property taxes and income taxes at the State level was reviewed. A case where the 25% property tax exemption applies for all years, including the first five years, was reviewed. Also, a case where no tax incentives are applied was reviewed.

The full waiver of taxes has a minimal effect on the baseline. This would only further reduce the property taxes from $9000 per year after year 5 to zero. Therefore, the effect on twenty-year return on investment is $135,000. If the tax waiver for the first five years is not included, this also has a minimal effect on return on investment, resulting in a loss of $63,000 in 1999 dollars through the first twenty years. The removal of all incentives has a much larger effect. A full property tax payment (no 25% discount), and application of the 5% income tax to the production facility would result in a loss of $185,852 by year 20. This number would be significantly larger if the operation were to offset losses before year 20. The much larger concern is the application of a 7% sales tax on construction equipment. This would have the effect of adding $10.6 million to construction costs, and would result in an additional loss in the twenty-year return on investment of $18.9 million in 1999 dollars — for a total additional loss of $19.1 million over the baseline case.

5.2.16 Other State Government Incentives

The application of a State government producer credit was also assessed. This is often proposed as one of a number of incentives that could be provided by the New York State government to assist the ethanol industry in New York. For this case, a credit was designed that started at fifteen cents per gallon at the start of production. The credit is phased out between years 6 and 8.

The result of this credit is a twenty-year return on investment of $38.1 million. Although this would not be enough to justify the $253 million construction loan required, it is a significant assistance to the profitability of the plant. Additionally, it is valuable because it assists the plant in the early years, when cash flow problems tend to exist. Although this credit would not assist a biomass-to-ethanol plant if built today, it does have an effect that would be helpful to developing the corn-to-ethanol industry, and could also assist the biomass-to-ethanol industry in the future. States that have instituted this credit are the states with corn-to-ethanol projects in the construction phase at this time. Therefore, this should be reviewed in more detail by the biomass-to-ethanol investors as more economically feasible baseline plant designs are developed in future years.

5.2.17 Product Sale Price

The effects of a 15% higher ethanol product price due to increased demand and of a 15% lower product price due to lower-than-expected demand were assessed.

Much like feedstock costs, ethanol prices have a significant effect on the profitability of the production plant. Because these prices tend to vary with the price of oil and gasoline, they could potentially cause advantages or disadvantages to investors that would be unknown at the time of construction. A 15% adjustment in ethanol prices has the effect of adding (or subtracting) $10.4 million in 1999 dollars from the return on investment in any given year. If ethanol prices over twenty years stayed, on average, 15% higher than the baseline price of $1.15 per gallon, an additional return on investment of $137.3 million would result. If prices stayed 15% lower, the return on investment over twenty years would be $210.9 million less than the base case.

5.2.18 Market for Carbon Dioxide

The effect on profit was assessed for different CO_2 markets. If there is no market for CO_2 near the plant, CO_2 is not sold and no profit would be realized for this co-product. The effect of this condition was assessed. Based upon evidence of a lack of CO_2 availability for upstate New York producers, it is likely that this product is in high demand. If so, prices higher than our initial prediction ($7 per ton) are also possible, including $9 and/or $11 per ton. Effects of these higher prices were assessed.

A lack of a market for CO_2 would have a reasonable effect on plant profits, resulting in a loss of $869,000 per year (in 1999 dollars). This would reduce the twenty-year return on investment by $17.3 million. If a market was stronger than predicted, an additional $2 per ton would result in an additional $248,000 in each year (in 1999 dollars) and a total return that is $3.3 million higher than predicted. An additional $4 per ton would result in an additional $496,440 in each year (in 1999 dollars), and a total return that is $6.6 million higher than predicted.

5.2.19 Electricity Industry Issues

The electricity industry in New York is currently undergoing a complicated deregulation process, making electric costs very difficult to assess. The baseline prices that would be paid for electricity sold to the grid were provided by Niagara Mohawk Power Corporation. However, these prices may be higher, if they stay in the range of standard prices that Niagara Mohawk charges to customers that purchase electricity from Niagara Mohawk. On the other hand, continued competition could also drive prices even lower. Therefore, the effects of higher or lower (by 35%) electric costs were assessed.

A 35% increase or decrease in the price that the plant receives for electricity would have an effect of a corresponding increase or decrease of $1.3 million (in 1999 dollars) for each year that prices are effected. Because the plant is selling electricity as a co-product, the higher electrical prices will result in a better return on investment. Over the course of the twenty-year pro-forma period, the total return on investment would be $17.7 million higher if electricity prices were up 35%, and $26.8 million lower if electricity prices were down 35%. Most likely, electricity prices will begin at a rate higher than predicted, and decrease as the deregulated industry invites more competition. Therefore, investors should be aware that the quoted price is probably a reasonable twenty-year average, but that dependence upon this return in the later years is not advisable.

5.3 Conclusions From Sensitivity Analysis

The sensitivity analysis phase of the biomass-to-ethanol project outlines some of the issues and their effects on the magnitude of profitability that the plant could realize. Some advantages, like guarantees that lower interest rates or State producer credits, could have a significant impact on the profitability of the plant. Meanwhile, certain risk factors, like higher biomass costs or lower ethanol sale prices, could have a severe negative impact on even the most profitable production technology.

5.4 Job Creation Analysis

Finally, NYSTEC conducted a preliminary review of the effect on jobs and economic development that would be realized from a biomass-to-ethanol processing facility. These numbers are preliminary estimates, but they provide an idea of the potential that could be realized from a large processing facility at or near Sackets Harbor.

The result of this review is provided in Table 7 (on the following page), Tax Impacts, Incentive Impacts, and Job Creation Estimates. The initial pro-forma page on tax impacts outlined the effect of State taxes from plant jobs and their induced multiplier effects. Based upon information provided by the NY Corn Growers Association for the corn-to-ethanol industry, NYSTEC provided a preliminary assessment of on-farm and off-farm jobs created by this industry and the effect that this would have on State revenue. The extended form (Table 7) shows the effect of 500 additional indirect jobs from the farms and the trucking industry as well as their induced multiplier effects.

Table 7, Tax Impacts, Incentive Impacts, and Job Creation Estimates

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Taxable Income	(236,487)	(25,219,724)	(19,075,236)	(17,079,777)	(15,081,351)	(13,075,299)	(9,827,097)	(7,826,681)	(5,802,135)	(3,747,763)	(1,657,538)
Cumulative taxable	(236,487)	(25,456,211)	(44,531,448)	(61,611,225)	(76,692,576)	(89,767,875)	(99,594,971)	(107,421,652)	(113,223,787)	(116,971,550)	(118,629,088)
Federal Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
State Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sales Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Property Taxes	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000
Incentives	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$3,000	$3,000	$3,000	$3,000
Total Tax Burden	$0	$0	$0	$0	$0	$0	$0	$9,000	$9,000	$9,000	$9,000
Jobs Created	0	46	104	104	104	104	104	104	104	104	104
Mulitplier Jobs	0	55	125	125	125	125	125	125	125	125	125
Construction Jobs	200	200	20	0	0	0	0	0	0	0	0
On Farm Jobs	0	140	300	300	300	300	300	300	300	300	300
Trucking Jobs	0	80	200	200	200	200	200	200	200	200	200
Multiplier from Farm and Trucking Jobs	0	264	600	600	600	600	600	600	600	600	600
State/Local Job Impact	$0	$3,440	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819
Total Impact Value	$0	$2,699,617	$10,546,513	$10,390,129	$10,390,129	$10,390,129	$10,390,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129
Cost of $0.15 prod. credit	$0	$3,735,000	$9,000,000	$9,000,000	$9,000,000	$9,000,000	$9,000,000	$6,000,000	$3,000,000	$0	$0
Total Remaining Gov't Revenue	$0	($1,035,383)	$1,546,513	$1,390,129	$1,390,129	$1,390,129	$1,390,129	$4,399,129	$7,399,129	$10,399,129	$10,399,129

*** All values in current year dollars**

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Taxable Income	474,930	2,656,418	4,894,131	7,195,733	9,730,425	12,180,147	14,720,053	14,944,682	15,162,769	15,374,504	22,432,334
Cumulative taxable	(118,154,159)	(115,497,741)	(110,603,610)	(103,407,876)	(93,677,452)	(81,497,305)	(66,777,253)	(51,832,570)	(36,669,801)	(21,295,297)	1,137,037
Federal Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$397,963
State Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sales Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Property Taxes	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000
Incentives	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
Total Tax Burden	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$406,963
Jobs Created	104	104	104	104	104	104	104	104	104	104	104
Mulitplier Jobs	125	125	125	125	125	125	125	125	125	125	125
Construction Jobs	0	0	0	0	0	0	0	0	0	0	0
On Farm Jobs	300	300	300	300	300	300	300	300	300	300	300
Trucking Jobs	200	200	200	200	200	200	200	200	200	200	200
Multiplier from Farm and Trucking Jobs	600	600	600	600	600	600	600	600	600	600	600
State/Local Job Impact	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819
Total Impact Value	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,797,092
Cost of $0.15 prod. credit	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Remaining Gov't Revenue	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,797,092

The on-farm jobs are estimated based upon the job-creation data from the corn-to-ethanol industry. It is assumed that biomass processing will create fewer farm jobs than corn processing, because farm work will be limited to collecting and preparing stover and other wastes. Trucking jobs will be a significant factor for a biomass-to-ethanol processing facility that produces 60 million gallons of ethanol per year.

In an average year, all the jobs could bring the State and local governments $10.4 million in tax dollars. Even with a producer credit, the State and local governments would still see a benefit to the tax rolls in all but one year. After the credit is removed, a full $10.4 million benefit is realized for years beyond year 8.

NYSTEC would like to provide New York State with the most accurate assessment of the positive economic-development impacts, in addition to the positive environmental impacts, created by both on-farm and off-farm jobs for both corn-to-ethanol and biomass-to-ethanol processing. These activities will require additional work in the future.

6. CONCLUSIONS

Throughout the past year, NYSTEC has been evaluating the feasibility of ethanol production in New York State. A number of opportunities may exist to locate ethanol-processing plants in upstate New York and to take advantage of the available feedstocks and the support from the local crop-growing community.

Over the past few years, several organizations in New York State have been pursuing biomass energy as an alternative source for electric-power generation. The significant availability of hay and grasses, the significant waste product tonnage from the forest industry, the availability of urban wood waste, and the availability of former farmland for use as energy farms have all made New York a viable case for a biomass-to-electricity industry.

As the biomass-to-electricity research has shown, there is a significant quantity of available biomass feedstocks and feedstock capacity in upstate New York. Even without dedicated crops for energy generation, there is a supply of waste feedstocks such as corn stover that is adequate to supply a biomass-to-ethanol processing plant. With the addition of hay and straw, existing feedstocks could support multiple plant locations in upstate New York. NYSTEC is actively exploring a corn-to-ethanol processing industry for upstate New York. But, with a biomass resource that is larger and more underutilized than the corn resource, biomass-to-ethanol processing has the potential to open up the ethanol industry to New York State even if corn processing is not pursued.

In and around its study location at Sackets Harbor, NYSTEC reviewed several other locations with potential to be developed for ethanol processing facilities. Although the Sackets Harbor site was reviewed specifically for this project, it appears that site drawbacks may outweigh any advantages that could be found from locating near the existing grain processing operation of Robbins Corn and Bulk Service. Nonetheless, several suitable sites, including a number of former processing facilities, are available in the region within fifty miles of adequate feedstock supplies.

The biomass-to-ethanol technology is expensive and, therefore, works best if done on a large scale. This overwhelming plant size is a major barrier to feasibility of this project today. Construction costs are estimated to exceed $230 million. Even if the plant were to be significantly profitable, it is unlikely that upstate New York industries could finance this operation on their own. With active support of government agencies, other organizations could be willing and able to provide financing — or at least the necessary up-front equity to overcome such a cost. But it is more likely that biomass processing will become feasible when it can be accomplished for a lower construction cost or it can be operated in plants with capacities smaller than 60 million gallons per year.

Even if construction cost issues were overcome, a major barrier remains with the profitability of the operation in its current form. In the baseline pro-forma, profits are minimal, and the plant sees no cumulative return on the construction investment for the first nineteen years. In first full year of production, the ethanol plant sees a total loss of $19.1 million. The plant starts reporting yearly income beginning in Year 10, and sees a significant jump in income with the completion of the depreciation schedule in Year 20. By Year 20, the plant has an annual income of $38.6 million. Although a small profit is shown over the 20 years, it does not justify the large up-front capital investment. The plant provides a return-on-investment after 20 years that is barely 0.3% over the annual effects of inflation. Therefore, this baseline scenario will be unable to secure investments for construction.

The sensitivity analysis phase highlights a number of issues and opportunities that exist with the current and future biomass-to-ethanol processing technology. With some positive developments in place before the plant is in operation, there could be a significant positive impact on the profitability of the plant. Meanwhile, certain risk factors — like higher biomass costs or lower ethanol sale prices — could have a severe negative impact on even the most profitable production technology.

Feedstock costs also have a significant effect on profitability, return on investment, and feasibility of the biomass-to-ethanol processing industry. At the baseline cost of $35 per ton, the plant shows a twenty-year return on investment of $0.6 million. At $50 per ton, the return over 20 years is a negative $257.3 million. At $100 per ton, the return over 20 years is a negative $1,118.3 million. At $18 per ton, the return over 20 years is $190.9 million.

Ethanol prices have a significant effect on the profitability of the production plant. Because these prices tend to vary with the price of oil and gasoline (but not necessarily with the price of feedstocks), they could potentially cause advantages or disadvantages to investors. A 15% adjustment in ethanol prices has the effect of adding or subtracting $10.4 million (in 1999 dollars) to/from the return on investment in any given year.

With support from the government, the biomass-to-ethanol industry may move closer to reality. Two candidate government programs that were reviewed in the sensitivity analysis phase of this project have a significant effect on profitability. One such program entailed a loan guarantee that would bring down interest rates. While the baseline interest rate was set at 11%, a guarantee that brought rates down to 8% would show a return on investment of $51.6 million. The facility would show a profit in year 8. With a 3% interest rate the facility would show a profit in Year 1, and a total return on investment of $128.7 million. Another valuable government program would provide a production credit for ethanol producers. Some states have pursued such a policy to have corn-to-ethanol processors build in their state. The result of this seven-year credit is a twenty-year return on investment of $38.1 million. This is valuable because it assists the plant in the early years when cash flow problems tend to exist. Although this credit would not be large enough to make a biomass-to-ethanol plant financially feasible if built today, it does have an effect that would be helpful to developing the corn-to-ethanol industry, and also could assist the biomass-to-ethanol industry in the future.

NYSTEC also conducted a preliminary review of the jobs creation and economic development that would be realized from a biomass-to-ethanol processing facility. In an average year, all the jobs created by a 60-million-gallon-per-year plant could bring the State and local governments in New York $10.4 million in tax dollars. Even with a producer credit, the State and local governments would still see a benefit to the tax rolls in all but one year. After the credit is removed, the full $10.4 million benefit is realized for years beyond year 8. This type of data should be helpful in convincing State and local governments of the significant benefits that could be accrued in the operation of a local biomass-to-ethanol production facility.

7. Recommendations for Further Work

NYSTEC's Alternative Fuel Technology Center (AFTC) has learned a great deal about ethanol production while conducting this NREL-sponsored study. Its evaluation of New York State feedstock options, including a number of biomass alternatives, has provided a good foundation for insight into the cost drivers in the production process. This insight will help NYSTEC identify cost-effective solutions. In addition to examining the applicability (technical and cost) of NREL's lignocellulosic biomass technology to the New York State environment, NYSTEC also examined the current state of the art in corn-to-ethanol technology.

Results of NYSTEC's studies indicate that the lignocellulosic biomass technology for fuel ethanol production is not yet economically feasible for the New York State environment. However, the potentially significant positive aspects of this technology mark it as an excellent candidate for future application in New York State. Therefore, NYSTEC will continue to monitor the development and evolution of lignocellulosic biomass technology to assess the potential for a future successful implementation in New York State.

NYSTEC's findings resulting from the NREL study, coupled with its examination of the current state of the art in corn-to-ethanol technology, have revealed potential economics in New York State ethanol production that it feels warrant further investigation. In particular, NYSTEC recommends:

- Further work to ascertain the complete financial and market picture through the development of a business plan for New York State ethanol production implementation, and
- Evaluation of the economic viability of building a current state-of-the-art ethanol plant and scarring it to allow for future conversion to lignocellulosic biomass-based ethanol production.

The business plan development will logically continue NYSTEC's ethanol-feasibility work to the next step (given the favorable results seen in this project) and is expected to form the basis for New York State ethanol production moving from feasibility to reality in the future.

Appendix A

Feedstock Composition

Feedstock Composition Data Sheet

Feedstock / Product: Corn Stover
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 2.0 tons/acre
Source of Conv. Factor: NREL 1.8-2.0 dry tons/acre, NYSERDA 2.5 tons/acre
Other Info:

Location of Production	**5 yr Average**		**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	1,208,000		1,080,000	1,180,000	1,220,000	1,260,000	1,300,000
Production within North Country	49,720		40,600	45,800	53,400	53,800	55,000
Production on RCBS Farm Site	1,339		1,286	1,170	1,370	1,420	1,448

Additional Notes:

Assay Information

Source of Data: Stalk Residue Book provided by Raytheon
Source of Additional Data: NREL Feedstock Datasheet

		Raytheon	**NREL**
Total Solids			
Extractives (water and ethanol soluable)			2.11%
Glucose		38%	45.39%
Xylose		16%	23.86%
Galactose		1%	1.11%
Arabinose		2%	2.00%
Mannose		1%	0.00%
Klason lignin			18.53%
Acid soluable lignin			0.00%
Total ash			7.00%
Mass balance			0.02%
Cellulose		38.4%	
Pentosan		27.6%	
Lignin		34.3%	

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Grass
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info: Hay- other than Alfalfa

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	1,848,000		1,890,000	2,132,000	1,758,000	1,740,000	1,720,000
Production within North Country	354,740		369,000	416,200	321,600	325,400	341,500
Production on RCBS Farm Site	750		750	750	750	750	750

Additional Notes:

Assay Information

Timothy Hay

Source of Data: Dr. Lorin Harris, Utah State University (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Harris	NRB
Dry Matter			
Moisture			
Ash		5.8%	6.3%
Crude Protein		8.5%	
Ether Extract		2.7%	2.6%
Crude Fiber		33.5%	31.0%
Nitrogen Free Extract		49.5%	
Neutral Detergent Fiber			67%
Acid Detergent Fiber			36%
Cellulose			33%
Lignin			5.0%

Brome Hay

Source of Data: Dr. Lorin Harris, Utah State University (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Harris	NRB
Dry Matter			88%
Moisture			
Ash		8.6%	9.4%
Crude Protein		11.8%	16.0%
Ether Extract		2.6%	2.6%
Crude Fiber		32.0%	30.0%
Nitrogen Free Extract		45.0%	
Neutral Detergent Fiber			65%
Acid Detergent Fiber			35%
Cellulose			32%
Lignin			4.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Straw
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: Wheat .9 tons/acre, Oats .7 tons/acre, Rye 1.1/acre, Barley .7/acre
Source of Conv. Factor: NYCGA
Other Info:

Location of Production	**5 yr Average**	**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	294,740	273,900	307,800	281,500	278,400	332,100
Production within North Country	2,978				5,880	9,012
Production on RCBS Farm Site	212	272	243	221	189	135

Additional Notes:
RCBS- Wheat only
Regional data- 1996 and 1997 -Primarily Oats, Quantities of others negligible

Assay Information

Barley Straw

Source of Data: Animal Agriculture by HH Cole (Cole)
Location of Sample:
Other Information:
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Location of Add. Sample:

	Cole	NRB
Dry Matter		91%
Moisture	10.0%	
Ash	6.0%	7.1%
Crude Protein	3.7%	4.3%
Ether Extract	1.6%	1.9%
Crude Fiber	37.7%	42.0%
Nitrogen Free Extract	41.0%	
Neutral Detergent Fiber		80%
Acid Detergent Fiber		59%
Cellulose		37%
Lignin		11.0%

Straw, Assay Information, cont.

Wheat Straw

Source of Data: NREL Feedstock Datasheet
Location of Sample:
Other Information:
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Location of Add. Sample:

	NREL	NRB
Dry Matter		89%
Moisture		
Ash	11%	7.8%
Crude Protein		3.60%
Ether Extract		1.80%
Crude Fiber		41.60%
Nitrogen Free Extract		
Neutral Detergent Fiber		85%
Acid Detergent Fiber		54%
Cellulose		39%
Klason Lignin	15%	14.0%
Extractives	13%	
Glucose	37%	
Xylose	24%	

Oat Hay and Oat Straw

Source of Data: Dr. Lorin Harris, Utah State University (Oat Hay Only) (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (Oat Straw Only) (NRB)

	Harris	NRB
Dry Matter		92%
Moisture		
Ash	7.5%	7.8%
Crude Protein	9.2%	4.4%
Ether Extract	3.1%	2.2%
Crude Fiber	31.0%	40.5%
Nitrogen Free Extract	49.2%	
Neutral Detergent Fiber		70%
Acid Detergent Fiber		47%
Cellulose		40%
Lignin		14.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Papermill Waste
Units: Wet Tons (approx. 55% moisture content)
Source of Base Data: NYSEG report to NYSERDA (1998)
Conversion Factor: none
Source of Conv. Factor:
Other Info:

Location of Production	**5 yr Average**		**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	643,000		n/a	n/a	n/a	n/a	643,000
Production within North Country	151,000		n/a	n/a	n/a	n/a	151,000
Production on RCBS Farm Site	0		n/a	n/a	n/a	n/a	0

Additional Notes:
Data based on single year survey of all 50 mills in NYS.
No trend data is available for this feedstock, but paper production has been quite steady.
Industrial stoker coal market takes 263,000 tons per year

Assay Information

Source of Data: NREL data on waste paper from Fort Howard
Location of Sample: Fort Howard
Source of Additional Data: NYSEG study of wastes from two NYS plants / ESF national study

		Average	**St. Dev.**
Total Solids		38.3	0.06
Extractives (water and ethanol soluable)			
Glucose		22.18	0.57
Xylose		5.38	0.08
Galactose		0.11	0
Arabinose		0.23	0.02
Mannose		1.49	0.01
Klason lignin		16.98	0.34
Acid soluable lignin		0.8	0.01
Total ash		48.53	0.05
Mass balance		92.65	

Additional Data

Sample 1:	**As received**		**Dry basis**
Moisture Content:	55.52%		
Volatile Matter:	31.14%		70.01%
Fixed Carbon:	0.92%		2.07%
Ash:	12.42%		27.92%
Sulfur:	0.04%		0.08%
BTU/LB:	2154		4343
Lbs of SO2 per mBTU:			0.33
Lbs of Sulfur per mBTU:	0.186		
Percent Solids:			44.48%

Sample 2:	**As received**		**Dry basis**
Moisture Content:	70.02%		
Volatile Matter:	16.32%		54.43%
Fixed Carbon:	1.36%		4.53%
Ash:	12.30%		41.04%
Sulfur:	0.03%		0.08%
BTU/LB:	1398		4662
Lbs of SO2 per mBTU:			0.34
Lbs of Sulfur per mBTU:	0.215		
Percent Solids:			29.98%

Ash minerals in Sample 2:	
Silicon Dioxide	42.64%
Aluminium Oxide	30.63%
Ferric Oxide	1.31%
Titanium Dioxide	0.72%
Phosphorus Pentoxide	0.25%
Calcium Oxide	20.69%
Magnesium Oxide	0.93%
Sodium Oxide	0.26%
Potassium Oxide	0.19%
Sulfur Trioxide	0.80%

Nationwide Study
Here is data on analysis of paper mill wastes nationwide. New York has many different types of mills.

Heat Val MJ/kg	Type of mill	Solids	Ash	C	H	S	O	N
20.1	Bleached Pulp Mill	33.4	1.9	48.7	6.6	0.2	42.4	0.2
21.5	Pulp Mill	42.0	4.9	51.6	5.7	0.9	29.3	0.9
24.1	Kraft Mill	37.6	7.1	55.2	6.4	1.0	26.0	4.4
19.8	Kraft Mill	40.0	8.0	48.0	5.7	0.8	36.3	1.2
12.0	Deinking mill	42.0	20.2	28.8	3.5	0.2	18.8	0.5
12.2	Deinking mill	42.0	14.0	31.1	4.4	0.2	30.1	0.9
20.8	Recycled Mill	45.0	3.0	48.4	6.6	0.2	41.3	0.5
20.6	Recycled Mill	50.5	2.8	48.6	6.4	0.3	41.6	0.4
20.3	Bark	54.0	3.5	48.0	6.0	0.1	42.1	0.3
20.8	Bark	50.0	0.4	50.3	6.2	0.0	43.1	0.0
19.4	Wood chips	79.5	0.2	49.2	6.7	0.2	43.6	0.1
25.0	Wastepaper	92.0	7.0	48.7	7.0	0.1	37.1	0.1

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Corn
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	1,859,200		1,587,600	1,916,320	1,793,400	1,887,480	2,111,200
Production within North Country	69,185		56,000	64,980	73,102	74,435	77,409
Production on RCBS Farm Site	1,962		1,800	1,933	1,649	2,219	2,210

Additional Notes:

Assay Information

Source of Data: Animal Agriculture by HH Cole (Cole)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Cole	NRB
Dry Matter			77%
Moisture		11.0%	
Ash		1.1%	1.6%
Crude Protein		8.9%	
Ether Extract		3.9%	4.3%
Crude Fiber		2.0%	2.6%
Nitrogen Free Extract		73.1%	
Neutral Detergent Fiber			9%
Acid Detergent Fiber			3%
Cellulose			2%
Lignin			1.0%

Notes:

Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Corn Silage
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	7,779,200		7,810,000	8,216,000	6,790,000	7,905,000	8,175,000
Production within North Country	1,202,420		1,001,000	1,424,100	1,093,900	1,282,000	1,211,100
Production on RCBS Farm Site	1,246		880	1,300	1,050	1,650	1,350

Additional Notes:

Assay Information

Source of Data: Animal Agriculture by HH Cole (Cole)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Cole	NRB
Dry Matter			29%
Moisture		72.1%	
Ash		7.6%	7.2%
Crude Protein		2.3%	8.4%
Ether Extract		0.8%	3.0%
Crude Fiber		7.3%	32.3%
Nitrogen Free Extract		15.7%	
Neutral Detergent Fiber			53%
Acid Detergent Fiber			30%
Cellulose			23%
Lignin			5.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Brewery Waste
Units: Tons (dry solids)
Source of Base Data: Local news articles on breweries
Conversion Factor: 0.33 tons per barrel of beer produced
Source of Conv. Factor: United Nations Univerity studies
Other Info: Does not include microbrews

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	2,901,690		2,778,600	2,828,100	2,877,600	3,014,550	3,009,600
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

3 major breweries in upstate NY (FX Matt, Genesee, Anhauser-Busch) could contribute
Info is based on reliable production data. Conversion factor should be reviewed by Raytheon.

look for more information . . . DEC permits . . . Etc.

Assay Information

Source of Data: Spent grain data from Coors Brewery provided by NREL
Location of Sample: Golden CO
Source of Additional Data: Research studies

		Average	St. Dev.
Total Solids		80.63	0.12
Extractives (water and ethanol soluable)			
Glucose		27.86	0.05
Xylose		15.03	0.95
Galactose		2.33	0.18
Arabinose		7.12	0.32
Mannose		0	0
Klason lignin		35.42	13.23
Acid soluable lignin		5.06	0.03
Total ash		4.09	0.25
Mass balance			

Additional Data

	Brewers Dried grains percentage	Dried Spent Hops percentage	Grains & 6% Hops
Moisture	8.00%	8.04%	8.00%
Protein	25.00%	17.85%	24.57%
Fat	6.50%	4.90%	6.40%
Fibre	14.80%	27.77%	15.58%
Nitrogen Free Extract	42.00%	35.54%	41.61%
Ash	3.70%	5.90%	3.83%

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Cheese Whey
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: See Below
Source of Conv. Factor: Dave Brown, Cornell Coop. Ext.
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	219,853		200,588	248,534	208,048	214,726	227,367
Production within North Country							74,179
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
Conversion factors:
Cream & Neufchatel:7.5/lb. to liquid, .065 to dry;
Cottage (60%of creamed & lowfat production and curd production):8.5/lb. to liquid, .065 to dry;
All other cheese: 9.0/lb.to liquid, .068 to dry.
North Co. 1997 data for St. Law, Jeff, Lewis, Franklin, Clinton, Essex. Data only broken down by Italian and all other cheese w/o cottage. 18324.5 tons calc w/9 lb to liquid, .068 to dry; 129157 calc w/7.5 to liquid, .065 dry.

Assay Information

Source of Data: Dr. Lorin Harris, Utah State University (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Source of WET data: Dairy and Microbiology, E.M. Forster, 1957

		Harris	NRB
Dry Matter			93%
Moisture			
Ash		10.3%	9.8%
Crude Protein		14.7%	14.2%
Ether Extract		0.9%	0.7%
Crude Fiber			0.2%
Nitrogen Free Extract		74.1%	
Neutral Detergent Fiber			
Acid Detergent Fiber			
Cellulose			
Lignin			

Wet Data

		Forster
Moisture		93.0%
Lactose		4.9%
Nitrogen Comp		0.9%
Ash		0.6%
Fat		0.3%
Lactic Acid		0.2%

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Sweet Corn
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.67
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	**5 yr Average**		**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	149,856		168,518	150,717	149,611	138,047	142,388
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Type of Sample: Cob & Husk
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Type of Sample: Process Residue

		ASEB		**NRB**
		Cob	**Husk**	**Pro. Res.**
Dry Matter				32%
Moisture				
Cellulose		32.0%	38.0%	
Hemicellulose		42.0%	44.5%	
Lignin		9.0%	6.6%	
Protein		1.7%	1.9%	7.7%
Ash		1.2%	2.8%	4.9%
Ether Extract				5.2%
Crude Fiber				27%
Acid Detergent Fiber				34%

Notes:

ASEB Composition percentages are based on a 100g of fresh material produced
NRB Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Cabbage
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.32
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	**5 yr Average**	**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	19,240	23,360	19,488	16,320	14,880	22,154
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		92.40%
Ash		0.7%
Fat		0.2%
Total Carbohydrates		5.4%
Fiber		0.8%
Protein		1.3%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Beets
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.41
Source of Conv. Factor: J. Cooper, National Canners Assn
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	17,045	15,670	18,311	17,589	17,048	16,605
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		87.30%
Ash		1.1%
Fat		0.1%
Total Carbohydrates		9.9%
Fiber		0.8%
Protein		1.6%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Snap Beans
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.21
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	5 yr Average	1993	1994	1995	1996	1997
Statewide Production	14,281	16,279	14,847	16,134	12,789	11,357
Production within North Country	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimental Biology (ASEB)
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		91.00%
Ash		2.0%
Fat		0.3%
Total Carbohydrates		4.6%
Fiber		1.3%
Protein		2.2%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Grape Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.2
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	77,195		49,350	69,791	86,177	99,116	81,539
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Type of Sample: Grape Skin
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		81.60%
Ash		0.4%
Fat		1.0%
Total Carbohydrates		15.7%
Fiber		0.6%
Protein		1.3%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Apple Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 10% for Juice/Cider, 30% for Sauce
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	46,132		41,360	45,635	52,875	44,595	46,195
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Source of WET data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N)

		S & N		NRB
		Low	High	
Dry Matter				89%
Moisture		11.0%	12.5%	
Carbohydrates				
Nitrogen free extract		54.77%	59.29%	
Pectin		15.00%	18.00%	
Crude fiber		15.88%	20.55%	17.00%
Proteins		4.45%	5.67%	4.90%
Fat		3.75%	4.65%	
Ash		211.00%	3.50%	2.20%
Potassium (as K20)				0.46%
Phosphorus (as P2O5)				0.11%
Ether Extract				5.10%
Acid Detergent Fiber				26%

Wet Data

		S & N	
		Low	High
Dry Matter			
Moisture		66.4%	78.15%
Carbohydrates		9.5%	21.98%
Nitrogen free extract		54.77%	59.29%
Pectin		1.50%	2.50%
Crude fiber		4.30%	10.50%
Proteins		1.03%	1.82%
Fat		0.82%	1.43%
Ash		0.56%	2.27%
Potassium (as K20)		0.2%	1%
Phosphorus (as P2O5)		0.4%	0.7%
Ether Extract			
Acid Detergent Fiber			

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Carrots
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.48
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	**5 yr Average**		**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	8,218		12,240	7,392	7,968	6,768	6,720
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		ASEB	**NRB**
Dry Matter			12%
Moisture		88.0%	
Ash		0.8%	8.2%
Fat		0.2%	
Total Carbohydrate		9.7%	
Crude Protein		1.1%	9.9%
Ether Extract			1.3%
Crude Fiber		1.0%	9.7%
Nitrogen Free Extract			
Neutral Detergent Fiber			9%
Acid Detergent Fiber			8%
Cellulose			7%
Lignin			0.0%

Notes:

ASEB Composition percentages are based on a 100g of fresh material produced
NRB Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Peas
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.13
Source of Conv. Factor: J. Cooper, National Canners Assn
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	3,767		2,877	3,206	3,927	3,595	5,229
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Assay Information

Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Other Information: per 100g of fresh material produced
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		83.00%
Ash		1.1%
Fat		0.2%
Total Carbohydrates		12.0%
Fiber		1.2%
Protein		3.4%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Winery Waste (Grape Pumace from wine production)
Units: tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 23 pounds of pumace is produced for each 100 pounds of wine
Source of Conv. Factor: Gene Pierce, President of Glenora Winery
Other Info:

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	13,853		10,702	15,036	12,930	20,525	10,074
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
Wine data collected per gallon produced. Transferred into ton data based on 180 gallons / ton figure provided by Gene Pierce of Glenora Winery.
32% of wine (and 32% of pomace) is in the Finger Lakes region, the rest near Hudson, Erie, and Long Island.

Assay Information

Source of Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Source of Additional Data:

		NRB
Dry Matter		91%
Crude Protein		13.0%
Ether Extract		7.9%
Total Ash		10.3%
Crude Fiber		31.9%
Neutral Detergent Fiber		55%
Acid Detergent Figer		54%
Cellulose		
Lignin		35%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Cherry Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.15
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	**5 yr Average**		**1993**	**1994**	**1995**	**1996**	**1997**
Statewide Production	1,283		1,133	1,770	1,485	1,050	975
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Assay Information

Source of Data:
Source of Additional Data:

Dry Matter		
Moisture		
Ash		
Fat		
Total Carbohydrates		
Fiber		
Protein		

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Dedicated Feedstock Willow
Units: Dry Tons
Source of Base Data: SUNY ESF
Conversion Factor: 6 dry tons per acre
Source of Conv. Factor: SUNY ESF
Other Info: low production now on test farms only

Location of Production	5 yr Average		1993	1994	1995	1996	1997
Statewide Production	230		0	30	120	372	630
Production within North Country	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
Willow is well suited for idle lands with lower soil quality than corn acerage.
Willow is only being tried on test plots. SUNY predicts between 10,000 and 80,000 acres of willow in New York State by 2015 for electricity production.
Additional willow may be grown for ethanol production. Land availability is being measured by NYSTEC.
Numbers for 1993-1995 are estimates based on known information about project history

Assay Information

Source of Data: Environmental Science School / NYSEG study of local willows
Location of Sample: Tully test fields

Carbon:	40.38%		Moisture:	10.00%
Hydrogen:	6.23%		Ash:	1.47%
Nitrogen:	0.46%			
Oxygen:	41.40%		Btu/lb (dry):	8392
Sulfur:	0.05%		Btu/lb (wet):	7553

Notes:

Appendix B

Feedstock Cost

Feedstock Composition Data Sheet

Feedstock / Product: Corn Stover
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 2.0 tons/acre
Source of Conv. Factor: NREL 1.8-2.0 dry tons/acre, NYSERDA 2.5 tons/acre
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	1,208,000		1,080,000	1,180,000	1,220,000	1,260,000	1,300,000
Production in North Country Region	49,720		40,600	45,800	53,400	53,800	55,000
Production on RCBS Farm Site	1,339		1,286	1,170	1,370	1,420	1,448

Additional Notes:

Feedstock Costs

Market or Disposal Method: Based on sale for ethanol plants - estimated
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars / dry ton delivered (Harlan) / Dollars / dry ton before delivery (other)

Source of Data	5 yr Average		1993	1994	1995	1996	1997
NREL Harlan Indiana Demo Study	$32.00		n/a	n/a	n/a	n/a	$32.00
Other source	$30.00		n/a	n/a	n/a	n/a	$30.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Corn Stover
Source of Data: Stalk Residue Book provided by Raytheon
Source of Additional Data: NREL Feedstock Datasheet

		Raytheon	NREL
Total Solids			
Extractives (water and ethanol soluable)			2.11%
Glucose		38%	45.39%
Xylose		16%	23.86%
Galactose		1%	1.11%
Arabinose		2%	2.00%
Mannose		1%	0.00%
Klason lignin			18.53%
Acid soluable lignin			0.00%
Total ash			7.00%
Mass balance			0.02%
Cellulose		38.4%	
Pentosan		27.6%	
Lignin		34.3%	

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Grass
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info: Hay- other than Alfalfa

Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	1,848,000	1,890,000	2,132,000	1,758,000	1,740,000	1,720,000
Production in North Country Region	354,740	369,000	416,200	321,600	325,400	341,500
Production on RCBS Farm Site	750	750	750	750	750	750

Additional Notes:

Feedstock Costs

Market or Disposal Method: Sold
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average	1993	1994	1995	1996	1997
NY State Ag Statistics	$72.90	$74.50	$75.00	$70.00	$68.00	$77.00
	$0.00					

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Grass

Timothy Hay

Source of Data: Dr. Lorin Harris, Utah State University (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Harris	NRB
Dry Matter			
Moisture			
Ash		5.8%	6.3%
Crude Protein		8.5%	
Ether Extract		2.7%	2.6%
Crude Fiber		33.5%	31.0%
Nitrogen Free Extract		49.5%	
Neutral Detergent Fiber			67%
Acid Detergent Fiber			36%
Cellulose			33%
Lignin			5.0%

Brome Hay

Source of Data: Dr. Lorin Harris, Utah State University (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Harris	NRB
Dry Matter			88%
Moisture			
Ash		8.6%	9.4%
Crude Protein		11.8%	16.0%
Ether Extract		2.6%	2.6%
Crude Fiber		32.0%	30.0%
Nitrogen Free Extract		45.0%	
Neutral Detergent Fiber			65%
Acid Detergent Fiber			35%
Cellulose			32%
Lignin			4.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Straw
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: Wheat .9 tons/acre, Oats .7 tons/acre, Rye 1.1/acre, Barley .7/acre
Source of Conv. Factor: NYCGA
Other Info:

Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	294,740	273,900	307,800	281,500	278,400	332,100
Production in North Country Region	7,446	n/a	n/a	n/a	5,880	9,012
Production on RCBS Farm Site	212	272	243	221	189	135

Additional Notes:
RCBS- Wheat only
Regional data- 1996 and 1997 -North Country data primarily Oats, Quantities of others negligible
Regional data from 1996 in the Finger Lakes and Central Regions are estimates for Rye and Barley based on 97.

Feedstock Costs

Market or Disposal Method: Sold
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average	1993	1994	1995	1996	1997
Robbins Corn and Bulk Service	$60.00	n/a	n/a	n/a	n/a	$60.00
	$0.00					

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Straw

Barley Straw

Source of Data: Animal Agriculture by HH Cole (Cole)
Location of Sample:
Other Information:
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Location of Add. Sample:

	Cole	NRB
Dry Matter		91%
Moisture	10.0%	
Ash	6.0%	7.1%
Crude Protein	3.7%	4.3%
Ether Extract	1.6%	1.9%
Crude Fiber	37.7%	42.0%
Nitrogen Free Extract	41.0%	
Neutral Detergent Fiber		80%
Acid Detergent Fiber		59%
Cellulose		37%
Lignin		11.0%

Wheat Straw

Source of Data: NREL Feedstock Datasheet
Location of Sample:
Other Information:
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Location of Add. Sample:

	NREL	NRB
Dry Matter		89%
Moisture		
Ash	11%	7.8%
Crude Protein		3.60%
Ether Extract		1.80%
Crude Fiber		41.60%
Nitrogen Free Extract		
Neutral Detergent Fiber		85%
Acid Detergent Fiber		54%
Cellulose		39%
Klason Lignin	15%	14.0%
Extractives	13%	
Glucose	37%	
Xylose	24%	

Oat Hay and Oat Straw

Source of Data: Dr. Lorin Harris, Utah State University (Oat Hay Only) (Harris)
Source of Additional Data: Nutrient Req. of Beef Cattle, Nat'l Research Board (Oat Straw Only) (NRB)

	Harris	NRB
Dry Matter		92%
Moisture		
Ash	7.5%	7.8%
Crude Protein	9.2%	4.4%
Ether Extract	3.1%	2.2%
Crude Fiber	31.0%	40.5%
Nitrogen Free Extract	49.2%	
Neutral Detergent Fiber		70%
Acid Detergent Fiber		47%
Cellulose		40%
Lignin		14.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Papermill Waste
Units: Wet Tons (approx. 55% moisture content)
Source of Base Data: NYSEG report to NYSERDA (1998)
Conversion Factor: none
Source of Conv. Factor:
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	643,000		n/a	n/a	n/a	n/a	643,000
Production in North Country Region	151,000		n/a	n/a	n/a	n/a	151,000
Production on RCBS Farm Site	0		n/a	n/a	n/a	n/a	0

Additional Notes:
Data based on single year survey of all 50 mills in NYS.
No trend data is available for this feedstock, but paper production has been quite steady.
Industrial stoker coal market takes 263,000 tons per year

Feedstock Costs

Market or Disposal Method: Sent to landfill or other interested buyers
Additional Market or Method: Paper companies will pay $21 per ton to have this removed
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
NYSEG Study	-$21.00		n/a	n/a	n/a	n/a	-$21.00
	$0.00						

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Papermill Waste
Source of Data: NREL data on waste paper from Fort Howard
Location of Sample: Fort Howard
Source of Additional Data: NYSEG study of wastes from two NYS plants / ESF national study

		Average	St. Dev.
Total Solids		38.3	0.06
Extractives (water and ethanol soluable)			
Glucose		22.18	0.57
Xylose		5.38	0.08
Galactose		0.11	0
Arabinose		0.23	0.02
Mannose		1.49	0.01
Klason lignin		16.98	0.34
Acid soluable lignin		0.8	0.01
Total ash		48.53	0.05
Mass balance		92.65	

Additional Data

Sample 1:	As received		Dry basis
Moisture Content:	55.52%		
Volatile Matter:	31.14%		70.01%
Fixed Carbon:	0.92%		2.07%
Ash:	12.42%		27.92%
Sulfur:	0.04%		0.08%
BTU/LB:	2154		4343
Lbs of SO2 per mBTU:			0.33
Lbs of Sulfur per mBTU:	0.186		
Percent Solids:			44.48%

Sample 2:	As received		Dry basis
Moisture Content:	70.02%		
Volatile Matter:	16.32%		54.43%
Fixed Carbon:	1.36%		4.53%
Ash:	12.30%		41.04%
Sulfur:	0.03%		0.08%
BTU/LB:	1398		4662
Lbs of SO2 per mBTU:			0.34
Lbs of Sulfur per mBTU:	0.215		
Percent Solids:			29.98%

Ash minerals in Sample 2:	
Silicon Dioxide	42.64%
Aluminium Oxide	30.63%
Ferric Oxide	1.31%
Titanium Dioxide	0.72%
Phosphorus Pentoxide	0.25%
Calcium Oxide	20.69%
Magnesium Oxide	0.93%
Sodium Oxide	0.26%
Potassium Oxide	0.19%
Sulfur Trioxide	0.80%

Nationwide Study
Here is data on analysis of paper mill wastes nationwide. New York has many different types of mills.

Heat Val MJ/kg	Type of mill	Solids	Ash	C	H	S	O	N
20.1	Bleached Pulp Mill	33.4	1.9	48.7	6.6	0.2	42.4	0.2
21.5	Pulp Mill	42.0	4.9	51.6	5.7	0.9	29.3	0.9
24.1	Kraft Mill	37.6	7.1	55.2	6.4	1.0	26.0	4.4
19.8	Kraft Mill	40.0	8.0	48.0	5.7	0.8	36.3	1.2
12.0	Deinking mill	42.0	20.2	28.8	3.5	0.2	18.8	0.5
12.2	Deinking mill	42.0	14.0	31.1	4.4	0.2	30.1	0.9
20.8	Recycled Mill	45.0	3.0	48.4	6.6	0.2	41.3	0.5
20.6	Recycled Mill	50.5	2.8	48.6	6.4	0.3	41.6	0.4
20.3	Bark	54.0	3.5	48.0	6.0	0.1	42.1	0.3
20.8	Bark	50.0	0.4	50.3	6.2	0.0	43.1	0.0
19.4	Wood chips	79.5	0.2	49.2	6.7	0.2	43.6	0.1
25.0	Wastepaper	92.0	7.0	48.7	7.0	0.1	37.1	0.1

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Corn
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info:

Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	1,859,200	1,587,600	1,916,320	1,793,400	1,887,480	2,111,200
Production in North Country Region	69,185	56,000	64,980	73,102	74,435	77,409
Production on RCBS Farm Site	1,962	1,800	1,933	1,649	2,219	2,210

Additional Notes:

Feedstock Costs

Market or Disposal Method: Market sales
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per bushel

Source of Data	5 yr Average	1993	1994	1995	1996	1997
NY State Ag Statistics	$3.06	$2.85	$2.65	$3.85	$2.98	$2.95
	$0.00					

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Corn
Source of Data: Animal Agriculture by HH Cole (Cole)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Cole	NRB
Dry Matter			77%
Moisture		11.0%	
Ash		1.1%	1.6%
Crude Protein		8.9%	
Ether Extract		3.9%	4.3%
Crude Fiber		2.0%	2.6%
Nitrogen Free Extract		73.1%	
Neutral Detergent Fiber			9%
Acid Detergent Fiber			3%
Cellulose			2%
Lignin			1.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Corn Silage
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor:
Source of Conv. Factor:
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	7,779,200		7,810,000	8,216,000	6,790,000	7,905,000	8,175,000
Production in North Country Region	1,202,420		1,001,000	1,424,100	1,093,900	1,282,000	1,211,100
Production on RCBS Farm Site	1,246		880	1,300	1,050	1,650	1,350

Additional Notes:

Feedstock Costs

Market or Disposal Method: Market sales
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
NY State Ag Statistics	$26.30		$24.10	$22.70	$24.50	$25.80	$34.40
	$0.00						

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Corn Silage
Source of Data: Animal Agriculture by HH Cole (Cole)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		Cole	NRB
Dry Matter			29%
Moisture		72.1%	
Ash		7.6%	7.2%
Crude Protein		2.3%	8.4%
Ether Extract		0.8%	3.0%
Crude Fiber		7.3%	32.3%
Nitrogen Free Extract		15.7%	
Neutral Detergent Fiber			53%
Acid Detergent Fiber			30%
Cellulose			23%
Lignin			5.0%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Brewery Waste
Units: Tons (dry solids)
Source of Base Data: Local news articles on breweries
Conversion Factor: 0.33 tons per barrel of beer produced
Source of Conv. Factor: United Nations Univerity studies
Other Info: Does not include microbrews

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	2,901,690		2,778,600	2,828,100	2,877,600	3,014,550	3,009,600
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
3 major breweries in upstate NY (FX Matt, Genesee, Anhauser-Busch) could contribute
Info is based on reliable production data. Conversion factor should be reviewed by Technology Provider.

Feedstock Costs

Market or Disposal Method:
Additional Market or Method: May be given away to farmers (+ transport cost) as feed.
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Research on breweries	$0.00		n/a	n/a	n/a	n/a	$0.00
	$0.00						

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Brewery Waste
Source of Data: Spent grain data from Coors Brewery provided by NREL
Location of Sample: Golden CO
Source of Additional Data: Research studies

		Average	St. Dev.
Total Solids		80.63	0.12
Extractives (water and ethanol soluable)			
Glucose		27.86	0.05
Xylose		15.03	0.95
Galactose		2.33	0.18
Arabinose		7.12	0.32
Mannose		0	0
Klason lignin		35.42	13.23
Acid soluable lignin		5.06	0.03
Total ash		4.09	0.25
Mass balance			

Additional Data

	Brewers Dried grains percentage	Dried Spent Hops percentage	Grains & 6% Hops
Moisture	8.00%	8.04%	8.00%
Protein	25.00%	17.85%	24.57%
Fat	6.50%	4.90%	6.40%
Fibre	14.80%	27.77%	15.58%
Nitrogen Free Extract	42.00%	35.54%	41.61%
Ash	3.70%	5.90%	3.83%

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Cheese Whey
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: See Below
Source of Conv. Factor: Dave Brown, Cornell Coop. Ext.
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	219,853		200,588	248,534	208,048	214,726	227,367
Production in North Country Region	74,179		n/a	n/a	n/a	n/a	74,179
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
Conversion Factors: Cream & Neufchatel:7.5/lb. to liquid, .065 to dry;
Cottage (60%of creamed & lowfat production and curd production):8.5/lb. to liquid, .065 to dry;
All other cheese: 9.0/lb.to liquid, .068 to dry.
Cent/FL/East. 1997 data only broken down by Italian, cottage, and all
North Co. 1997 data for St. Law, Jeff, Lewis, Franklin, Clinton, Essex. Data only broken down by Italian and all other cheese w/o cottage. 18324.5 tons calc.w/9.0 lb to liquid, .068 to dry. 129157.5 tons calc w/7.5 to liquid

Feedstock Costs

Market or Disposal Method: Disposed. Companies will pay to have this removed
Additional Market or Method: Can be mixed into feed for animals. Delivered free or for small transport fee.
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Average disposal cost in 1977	-$5.15		n/a	n/a	n/a	n/a	-$5.15

Transportation Method and Cost

Method to Transport to Plant:
Basis of Cost Estimate:
Cost to Transport: n/a per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Cheese Whey
Source of Data: Dr. Lorin Harris, Utah State University (Harris)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Source of WET data: Dairy and Microbiology, E.M. Forster, 1957

		Harris	NRB
Dry Matter			93%
Moisture			
Ash		10.3%	9.8%
Crude Protein		14.7%	14.2%
Ether Extract		0.9%	0.7%
Crude Fiber			0.2%
Nitrogen Free Extract		74.1%	
Neutral Detergent Fiber			
Acid Detergent Fiber			
Cellulose			
Lignin			

Wet Data

		Forster
Moisture		93.0%
Lactose		4.9%
Nitrogen Comp		0.9%
Ash		0.6%
Fat		0.3%
Lactic Acid		0.2%

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Sweet Corn
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.67
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	149,856		168,518	150,717	149,611	138,047	142,388
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Waste from Sweet Corn
Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Type of Sample: Cob & Husk
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Type of Sample: Process Residue

		ASEB		NRB
		Cob	Husk	Pro. Res.
Dry Matter				32%
Moisture				
Cellulose		32.0%	38.0%	
Hemicellulose		42.0%	44.5%	
Lignin		9.0%	6.6%	
Protein		1.7%	1.9%	7.7%
Ash		1.2%	2.8%	4.9%
Ether Extract				5.2%
Crude Fiber				27%
Acid Detergent Fiber				34%

Notes:
ASEB Composition percentages are based on a 100g of fresh material produced
NRB Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Cabbage
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.32
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	19,240		23,360	19,488	16,320	14,880	22,154
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Waste from Cabbage
Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		92.40%
Ash		0.7%
Fat		0.2%
Total Carbohydrates		5.4%
Fiber		0.8%
Protein		1.3%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Beets
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.41
Source of Conv. Factor: J. Cooper, National Canners Assn
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	17,045		15,670	18,311	17,589	17,048	16,605
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Waste from Beets
Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		87.30%
Ash		1.1%
Fat		0.1%
Total Carbohydrates		9.9%
Fiber		0.8%
Protein		1.6%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Snap Beans
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.21
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	14,281	16,279	14,847	16,134	12,789	11,357
Production in North Country Region	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average	1993	1994	1995	1996	1997
Processing Plants	-$60.00	n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00	n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Waste from Snap Beans
Source of Data: Fed. Of American Society for Experimental Biology (ASEB)
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		91.00%
Ash		2.0%
Fat		0.3%
Total Carbohydrates		4.6%
Fiber		1.3%
Protein		2.2%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Grape Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.2
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average	1993	1994	1995	1996	1997
Statewide Production	77,195	49,350	69,791	86,177	99,116	81,539
Production in North Country Region	0	0	0	0	0	0
Production on RCBS Farm Site	0	0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average	1993	1994	1995	1996	1997
Processing Plants	-$60.00	n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00	n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Grape Pomace
Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Type of Sample: Grape Skin
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		81.60%
Ash		0.4%
Fat		1.0%
Total Carbohydrates		15.7%
Fiber		0.6%
Protein		1.3%

Notes:

Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Apple Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 10% for Juice/Cider, 30% for Sauce / Canned
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	46,132		41,360	45,635	52,875	44,595	46,195
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method: Pay $10 to $20 per ton to transport away
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above | per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Apple Pomace
Source of Data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Source of WET data: NYS Ag Exp. Station (Geneva), per Smock & Neuburt paper, 1950 (S&N)

		S & N		NRB
		Low	High	
Dry Matter				89%
Moisture		11.0%	12.5%	
Carbohydrates				
Nitrogen free extract		54.77%	59.29%	
Pectin		15.00%	18.00%	
Crude fiber		15.88%	20.55%	17.00%
Proteins		4.45%	5.67%	4.90%
Fat		3.75%	4.65%	
Ash		211.00%	3.50%	2.20%
Potassium (as K20)				0.46%
Phosphorus (as P2O5)				0.11%
Ether Extract				5.10%
Acid Detergent Fiber				26%

Wet Data

		S & N	
		Low	High
Dry Matter			
Moisture		66.4%	78.15%
Carbohydrates		9.5%	21.98%
Nitrogen free extract		54.77%	59.29%
Pectin		1.50%	2.50%
Crude fiber		4.30%	10.50%
Proteins		1.03%	1.82%
Fat		0.82%	1.43%
Ash		0.56%	2.27%
Potassium (as K20)		0.2%	1%
Phosphorus (as P2O5)		0.4%	0.7%
Ether Extract			
Acid Detergent Fiber			

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Carrots
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.48
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	8,218		12,240	7,392	7,968	6,768	6,720
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Waste from Carrots
Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Source of Additional Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)

		ASEB	NRB
Dry Matter			12%
Moisture		88.0%	
Ash		0.8%	8.2%
Fat		0.2%	
Total Carbohydrate		9.7%	
Crude Protein		1.1%	9.9%
Ether Extract			1.3%
Crude Fiber		1.0%	9.7%
Nitrogen Free Extract			
Neutral Detergent Fiber			9%
Acid Detergent Fiber			8%
Cellulose			7%
Lignin			0.0%

Notes:

ASEB Composition percentages are based on a 100g of fresh material produced
NRB Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Waste from Peas
Units: Tons Wet Basis
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.13
Source of Conv. Factor: J. Cooper, National Canners Assn
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	3,767		2,877	3,206	3,927	3,595	5,229
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Waste from Peas
Source of Data: Fed. Of American Society for Experimentl Biology (ASEB)
Other Information: per 100g of fresh material produced
Source of Additional Data:

		ASEB
Dry Matter		
Moisture		83.00%
Ash		1.1%
Fat		0.2%
Total Carbohydrates		12.0%
Fiber		1.2%
Protein		3.4%

Notes:
Composition percentages are based on a 100g of fresh material produced

Feedstock Composition Data Sheet

Feedstock / Product: Winery Waste (Grape Pumace from wine production)
Units: tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 23 pounds of pumace is produced for each 100 pounds of wine
Source of Conv. Factor: Gene Pierce, President of Glenora Winery
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	13,853		10,702	15,036	12,930	20,525	10,074
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
Wine data collected per gallon produced. Transferred into ton data based on 180 gallons / ton figure provided by Gene Pierce of Glenora Winery.
32% of wine (and 32% of pomace) is in the Finger Lakes region, the rest near Hudson, Erie, and Long Island.

Feedstock Costs

Market or Disposal Method: Land spread on-site. No value.
Additional Market or Method: Some wineries will make grapesead oil or mix into compost, but none in New York.
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Gleonra Winery / NY Wine Assoc.	$0.00		$0.00	$0.00	$0.00	$0.00	$0.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Winery Waste (Grape Pumace from wine production)
Source of Data: Nutrient Requirements of Beef Cattle, National Research Board (NRB)
Source of Additional Data:

		NRB
Dry Matter		91%
Crude Protein		13.0%
Ether Extract		7.9%
Total Ash		10.3%
Crude Fiber		31.9%
Neutral Detergent Fiber		55%
Acid Detergent Figer		54%
Cellulose		
Lignin		35%

Notes:
Composition percentages are based on a 100% dry matter basis.

Feedstock Composition Data Sheet

Feedstock / Product: Cherry Pomace
Units: Tons
Source of Base Data: NYS Ag Statistics
Conversion Factor: 0.15
Source of Conv. Factor: J. Cooper, National Canners Assn.
Other Info:

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	1,283		1,133	1,770	1,485	1,050	975
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:

Regional data is approximate, based upon regional yields. Use of these yields is estimated to match state ratios, but is unknown on a regional basis.

Feedstock Costs

Market or Disposal Method: Solid Waste Disposal - Price paid for pick-up
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per Ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Processing Plants	-$60.00		n/a	n/a	n/a	n/a	-$60.00
Processing Plants	-$65.00		n/a	n/a	n/a	n/a	-$65.00

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: included above per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Cherry Pomace
Source of Data: No data available
Source of Additional Data:

Dry Matter		
Moisture		
Ash		
Fat		
Total Carbohydrates		
Fiber		
Protein		

Notes:

Feedstock Composition Data Sheet

Feedstock / Product: Dedicated Feedstock Willow
Units: Dry Tons
Source of Base Data: SUNY ESF
Conversion Factor: 6 dry tons per acre
Source of Conv. Factor: SUNY ESF
Other Info: low production now on test farms only

Location of Production	Average		1993	1994	1995	1996	1997
Statewide Production	112		20	20	20	150	350
Production in North Country Region	0		0	0	0	0	0
Production on RCBS Farm Site	0		0	0	0	0	0

Additional Notes:
Willow is well suited for idle lands with lower soil quality than corn acerage.
Willow is only being tried on test plots. SUNY predicts between 10,000 and 80,000 acres of willow in New York State by 2015 for electricity production.
Additional willow may be grown for ethanol production. Land availability is being measured by NYSTEC.
Numbers for 1993-1995 are estimates based on known information about project history

Feedstock Costs

Market or Disposal Method: Burned for electricity. Cost based on test farm estimates by Anteres Grp.
Additional Market or Method:
Additional Costs not Quantified:
Unit of measure for cost: Dollars per dry ton

Source of Data	5 yr Average		1993	1994	1995	1996	1997
Salix Consortium / SRC	$128.30						$128.30

Transportation Method and Cost

Method to Transport to Plant: Dry feedstock sent by truck
Basis of Cost Estimate: 35 mile trucking average distance to plant
Cost to Transport: $7.75 per Ton

Feedstock Composition - Assay Information

Feedstock / Product: Dedicated Feedstock Willow
Source of Data: Environmental Science School / NYSEG study of local willows
Location of Sample: Tully test fields

Carbon:	40.38%	Moisture:	10.00%
Hydrogen:	6.23%	Ash:	1.47%
Nitrogen:	0.46%		
Oxygen:	41.40%	Btu/lb (dry):	8392
Sulfur:	0.05%	Btu/lb (wet):	7553

Notes:

Appendix C

Evaluation of Biomass-to-Ethanol Processing for Building a Bridge to the Corn Ethanol Industry

(Raytheon Engineering and Constructors, Inc.)

NYSTEC

EVALUATION OF

BIOMASS TO ETHANOL PROCESSING

FOR

BUILDING A BRIDGE TO THE CORN ETHANOL INDUSTRY

FOR

NYSTEC

NEW YORK STATE
TECHNOLOGY ENTERPRISE CORPORATION
TA029/SC01
DE-AC-36-98-GO10337

BY: RAYTHEON ENGINEERING & CONSTRUCTORS, INC.
PROJECT 78849.001

JULY, 1999

NREL Draft Final Report
Building a Bridge to the Corn Ethanol Industry

INTRODUCTION

This evaluation is produced in support of New York State Technology Enterprise Corporation Biomass to Ethanol Study. This report contains:

- Non-specific site selection criteria
- An evaluation of the Robbins Corn & Bulk Service Grain processing facility, located in the Socketts Harbor, NY for the feasibility of producing ethanol from biomass
- Review of NREL process design and database
- The sizing of a biomass conversion plant and the next steps to building the facility.
- Cost estimate for non-site specific biomass plant
- The sizing of a corn to ethanol conversion plant for comparison to the biomass plant
- Cost estimate for non-site specific corn to ethanol plant.

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I. ROBBINS CORN AND BULK SERVICE EVALUATION

A. General Site Selection Criteria

Based on the Site Layout Study, a minimum site of 35-40 acres is required for the biomass plant. The biomass Site Layout Study has dimensions of 1320' x 1080' (33 acres m/l) in a feasibility type arrangement. This size allows for the plant to be sized at 80 MM gal/yr, if planned up front. This is a feasible size plant based on review of the NREL data and use of the proposed biomass handling system extrapolated to four (4) bale conveyors (see Process Description).

There are assumptions made about efficiency of land area usage, soil support characteristics, logistics, and utilities in the Site Layout Study that may not apply to all sites. Additional considerations should be given to odor buffer space, expandability, and especially possible co-location of a grain to ethanol processing plant that would require 35 to 40 acres.

Land Area Use

The layout and estimate assumes that railroad service is available near the edge of the property. It also assumes that there are no strange boundary conditions, rights-of-way restrictions, or other restricted areas within the limits of the site, such as springs, sink holes, wet lands, etc.

Soil Support Characteristics

Poor soil conditions could cause the plant to expand in area to provide the necessary support for large tanks and heavy equipment. Special support structures are not generally included as identified items in a feasibility study (piles, caissons, removal and replacement of subsoils.)

Logistics

Truck traffic could be as high as 240 to 250 deliveries per day of biomass and other materials (about a truck every 5 minutes entering and leaving). These will be mostly flatbed trucks loaded with 30,000 to 44,000 pound loads of biomass, delivering 5 to 6 days per week. The other materials will be delivered in typical over-the-road semi-tractor trailer units. The roadways need to be state highway or Interstate class. I doubt that county level roads will hold up under the traffic loads. Typical rural roadways for immediate plant access are not acceptable.

Rail access is a must have for moving the ethanol. At 60 MM gal/yr, rail traffic will be about 2000 cars/yr (30,000 gal/car rated at 34,500 gal capacity) just for the ethanol. Unleaded gas should probably also come by rail because the backhaul is less costly. If railroad transportation were not used, the equivalent ethanol truck trailer traffic would be about 5 times the railcar traffic. This would probably overwhelm the roadway access to the plant.

Utilities – Power

The plant will need a100 KV power source. I do not know the standard voltage used in NY near where this plant will be located, but if it is 115 KV, 145 KV, or some other voltage, it does not matter (15 KV power is not sufficient). Power consumption could peak as high as 20-30 Megawatts at the site when fully built out. Cost information for power transmission lines are not readily available because of the specialized applications installed by power companies.

Utilities - Water

Per the simulation, the water make-up to the plant is 500 gal/min. I would suggest that 600 gal/min be used as the basis. There are warnings around the water balance in the simulation that will take some engineering effort, that is not currently funded, to verify the exact needs. There also may be some ways to reduce the fresh water requirement. If water cannot be obtained from a public system, a 600 gal/min well, a standard size dependent on the aquifer available, would be covered by the current contingency.

Utilities - Natural Gas

There is a need for 1600 therms/hr to run the plant during startup before there are byproducts available for heat and power generation. There might be an opportunity to gain some revenue during operation with the byproducts. There will be about 1500 therms/hr available that could be used for additional power co-generation on a permanent basis with slightly larger boilers and generator.

Other Infrastructure Elements

There will be water discharged from the plant. There will be storm water runoff that needs to go its normal way to the water shed. There will be domestic water discharge. The domestic water preferably needs to discharge to a sewer system for sanitary wastes. However, it might run to a septic system. There will be laboratory water discharges. The laboratory preferably needs to discharge to a sewer system for sanitary wastes. If it cannot, then it would go to the process wastewater treatment system. It would be more convenient, but not necessarily a requirement, to discharge to a city sanitary sewer system than to treat all the different water discharges from the plant at the plant. Process wastes will still be treated at the plant for economical reasons.

The process is shown to discharge only vapors and wet sludge. There can be various vapors that are odoriferous at times, even though steps are taken to control emissions. In the simulation and discussion in NREL's reports, the wet sludge is landfilled. There is an opportunity to sell the wet sludge to someone else, as is done in other agricultural processing plants, as well as prepare it for land application on the farmer's fields to replenish micronutrients.

An existing boiler of about 270,000 pounds per hour capacity of 150 PSIG or greater steam could be utilized for process steam in the biomass plant. Likewise, the corn plant could use about 150,000 pounds per hour of 150 PSIG steam for process steam. The two plants could synergize on the steam, waste water treatment, power supply/use, and some of the logistics, if located next to each other.

B. Evaluation

Robbins Corn and Bulk Service (RCBS) was visited on March 10, 1999 (see attached notes). This service consists of a grain storage and transfer facility with grain dryer and scales (see attached pictures). Storage facilities like this are key to a grain ethanol plant to lower the bulk storage requirements at the plant. However, the storage capacity is too small compared to the requirements needed on-site for even a 15MM gal/year corn to ethanol plant. Additionally, the area served by this size operation will not provide sufficient biomass to support a large plant operation.

The utility services nearby are designed and installed for rural, and farm usage and could not support the plant needs without major upgrades. The electric utility services would need to be run from the nearest major power substation as an independent line.

A separate well could provide water. There is a small city water system close by, but it does not appear to be sized for this type of intended operation.

Natural gas would probably need to be piped from the main north-south trunk line over 4 miles away. There appear to be only small services close by for residential and small business usage.

The county road life would be shortened with the predicted industrial truck traffic loads. Ethanol products could be trucked to the rail service for bulk distribution, or to other nearby users, but at much greater operating costs.

The North Country Area Potential chart analysis for biomass feedstock shows support for about a 24MM gal/yr plant. If Oswego and 1/3 of Oneida county are added to the North Country biomass pool, the plant capacity approaches 30MM gal/yr (within the 50-60 mile radius from RCBS).

The State Wide Potential chart analysis for biomass feedstock shows support for about 4 – 60MM gal/yr plants or 3 – 80MM gal/yr plants. A plant needs to be located in the middle of a broad area to supply feedstock. RCBS, Watertown, and even some upcoming sites (see Charthage on the Internet) suffer from the effects of nearby large bodies of water that do not produce biomass for this plant. A place like Griffiss AFB, or the shutdown Miller Brewery are better located to have sufficient biomass close by.

In conclusion, there are other sites that offer better opportunities for capacity and reduced capital investment for a plant like this. The other possible sites could be near Rome, or Syracuse, or in west central New York.

POTENTIAL RON ROBBINS FARM ALCOHOL PRODUCTION BASIS

MATERIAL		CORN STOVER	GRASS	STRAW	PAPERMILL RESIDUE	CORN	BREWERY SOLIDS	CHEESE WHEY	SWEET CORN	CABBAGE	BEETS	SNAP BEANS	GRAPES	APPLE POMACE	CARROTS	PEAS	WINERY WASTE	CHERRIES	WILLOW BIOMASS
COMPONENT	UNITS																		
Production Rate	tons/yr	1,339	750	212	0	1,962	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent Solids	%	85.00%	88.00%	85.00%	45.00%	89.00%	92.00%	7.00%	32.00%	7.60%	12.70%	9.00%	18.40%	89.00%	12.00%	17.00%	91.00%	18.40%	90.00%
Percent Water	%	15.00%	12.00%	15.00%	55.00%	11.00%	8.00%	93.00%	68.00%	92.40%	87.30%	91.00%	81.60%	11.00%	88.00%	83.00%	9.00%	81.60%	10.00%
Gallons of Alcohol		87,356	43,932	12,137	0	214,535	0	0	0	0	0	0	0	0	0	0	0	0	0
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SOLUBLE SOLIDS		74.47%	66.94%	74.00%	65.80%	95.30%	55.43%		54.40%										
Glucose (SS)	%	45.39%	37.87%	37.00%	49.70%	75.30%	27.86%	74.10%	43.25%	4.99%	9.70%	4.30%	15.60%	54.84%	9.49%	11.78%	17.06%	15.60%	52.32%
Xylose (SS)	%	23.86%	22.31%	24.00%	4.80%		15.03%												18.65%
Arabinose (SS)	%	2.00%	3.78%		0.70%		7.12%												1.89%
Other Sugars (SS)	%	1.11%	2.98%				2.33%												6.19%
Cellobiose (SS)	%																		
Glucose Oligomers (SS)	%																		
Xylose Oligomers (SS)	%																		
Other Oligomers (SS)	%																		
Acetate (SS)	%																		
OH	%																		
SO_4 (SS)	%																		
Others Soluble Solids	%	2.11%		13.00%	10.60%	20.00%	3.09%	15.60%	11.15%	1.49%	1.60%	2.00%	2.20%	8.90%	1.26%	3.52%	20.70%	2.20%	
INSOLUBLE SOLIDS		25.53%	33.06%	26.00%	34.20%	4.70%	44.57%	10.30%	45.60%										
Cellulose (IS)	%					2.00%			35.00%	0.80%	0.80%	1.15%	0.60%	17.52%	0.97%	1.11%	17.38%	0.60%	
Xylan (IS)	%																		
Arabinan (IS)	%																		
Other Sugar Polymers (IS)	%																		
Cellulase (IS)	%																		
Biomass (IS)	%																		
Zymo (IS)	%																		
Lignin (IS)	%	18.53%	25.29%	15.00%	29.30%	1.30%	40.48%		7.80%					15.87%			35.00%		20.47%
INORGANICS	%	7.00%	5.80%	11.00%	4.90%	1.40%	4.09%	10.30%	2.80%	0.70%	1.09%	1.95%	0.40%	2.70%	0.77%	1.07%	10.30%	0.40%	0.49%
Ca^{++} (IS)	%																		
Other Insoluble Solids	%																		
Carbon Dioxide	%																		
Methane	%																		
Oxygen	%																		
Nitrogen	%																		
Ammonia	%																		
Other Inorganic Ions	%		1.97%																
Total Alcohol Potential		357,960	gal/yr																

POTENTIAL NORTH COUNTRY ALCOHOL PRODUCTION BASIS

MATERIAL		CORN STOVER	GRASS	STRAW	PAPERMILL RESIDUE	CORN	BREWERY SOLIDS	CHEESE WHEY	SWEET CORN	CABBAGE	BEETS	SNAP BEANS	GRAPES	APPLE POMACE	CARROTS	PEAS	WINERY WASTE	CHERRIES	WILLOW BIOMASS
COMPONENT	UNITS																		
Production Rate	tons/yr	49,720	354,740	2,978	151,000	69,185	0	74,179	0	0	0	0	0	0	0	0	0	0	0
Percent Solids	%	85.00%	88.00%	85.00%	45.00%	89.00%	92.00%	7.00%	32.00%	7.60%	12.70%	9.00%	18.40%	89.00%	12.00%	17.00%	91.00%	18.40%	90.00%
Percent Water	%	15.00%	12.00%	15.00%	55.00%	11.00%	8.00%	93.00%	68.00%	92.40%	87.30%	91.00%	81.60%	11.00%	88.00%	83.00%	9.00%	81.60%	10.00%
Gallons of Alcohol		3,243,727	20,779,276	170,485	4,186,755	7,565,044	0	437,934	0	0	0	0	0	0	0	0	0	0	0
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SOLUBLE SOLIDS		74.47%	66.94%	74.00%	65.80%	95.30%	55.43%		54.40%										
Glucose (SS)	%	45.39%	37.87%	37.00%	49.70%	75.30%	27.86%	74.10%	43.25%	4.99%	9.70%	4.30%	15.60%	54.84%	9.49%	11.78%	17.06%	15.60%	52.32%
Xylose (SS)	%	23.86%	22.31%	24.00%	4.80%		15.03%												18.65%
Arabinose (SS)	%	2.00%	3.78%		0.70%		7.12%												1.89%
Other Sugars (SS)	%	1.11%	2.98%				2.33%												6.19%
Cellobiose (SS)	%																		
Glucose Oligomers (SS)	%																		
Xylose Oligomers (SS)	%																		
Other Oligomers (SS)	%																		
Acetate (SS)	%																		
OH	%																		
SO_4 (SS)	%																		
Others Soluble Solids	%	2.11%		13.00%	10.60%	20.00%	3.09%	15.60%	11.15%	1.49%	1.60%	2.00%	2.20%	8.90%	1.26%	3.52%	20.70%	2.20%	
INSOLUBLE SOLIDS		25.53%	33.06%	26.00%	34.20%	4.70%	44.57%	10.30%	45.60%										
Cellulose (IS)	%					2.00%			35.00%	0.80%	0.80%	1.15%	0.60%	17.52%	0.97%	1.11%	17.38%	0.60%	
Xylan (IS)	%																		
Arabinan (IS)	%																		
Other Sugar Polymers (IS)	%																		
Cellulase (IS)	%																		
Biomass (IS)	%																		
Zymo (IS)	%																		
Lignin (IS)	%	18.53%	25.29%	15.00%	29.30%	1.30%	40.48%		7.80%					15.87%			35.00%		20.47%
INORGANICS	%	7.00%	5.80%	11.00%	4.90%	1.40%	4.09%	10.30%	2.80%	0.70%	1.09%	1.95%	0.40%	2.70%	0.77%	1.07%	10.30%	0.40%	0.49%
Ca^{++} (IS)	%																		
Other Insoluble Solids	%																		
Carbon Dioxide	%																		
Methane	%																		
Oxygen	%																		
Nitrogen	%																		
Ammonia	%																		
Other Inorganic Ions	%		1.97%																
Total Alcohol Potential		36,383,219	gal/yr																

North Country

Location

Northern New York is bordered by Lake Ontario on the west, the Adirondack mountains to the south, Vermont and Lake Champlain to the east, and the St. Lawrence Seaway and the provinces of Quebec and Ontario, Canada, to the north. The largest of New York's economic regions in area, it is the smallest in population.

Area

9,776 square miles

Weather

Mean Daily Temperature:
January 14.5 F
July 69.0 F

Workforce

Labor Force: 187,900
Households: 144,196
Total Personal Income: $6.6 billion
Per Capita Income: $15,235
Median Home Sales Price: $55,000

Population: 432,024
Clinton County 86,978
City of Plattsburgh 20,940
Essex County 37,950
Franklin County 49,121
Jefferson County 114,891
City of Watertown 27,869
Lewis County 27,661
St. Lawrence County 115,490
Village of Massena 11,468
City of Ogdensburg 13,174

Local Utilities

Niagara Mohawk Power Corp.
Offers negotiated flexible electric rates for many types of new businesses, negotiable gas transportation rates and fixed rate gas discounts.

New York State Electric & Gas Corp.

Offers negotiated flexible electric and fixed rate electric discounts for many types of new businesses and negotiable firm gas transportation service.

Market Access

The region's proximity to major Canadian population centers makes it a highly desirable location for companies serving the North American market, and for Canadian companies wishing to establish a branch operation in the U.S. Key Canadian markets (Montreal and Ottawa) are within an hour's drive.

Industries

Northern New York's economy is based primarily on the development of its abundant natural resources, including vast stretches of timber and valuable mineral deposits like zinc, talc and dolomite. Three industries-dairying, paper manufacturing and aluminum products-account for nearly half of all the manufacturing jobs in the region. Other major industry clusters include wood products, pharmaceuticals, apparel manufacturing and plastics.

Tourism plays a central role in the region's economy, and is a major employer. The Thousand islands, the Champlain Valley and the Adirondack Park are destinations for thousands of visitors each year.

Economic Development Zones

Lowville/Martinsburg
Moriah/Port Henry
Ogdensburg
Plattsburgh
Potsdam
Watertown

Selected Employers

ALCOA, Massena
James River Corporation, Carthage and Gouverneur
Champion International Corp., Deferiet
Corning, Canton
Mitel, Ogdensburg
Georgia Pacific, Plattsburgh
Reynolds Metals Company, Massena
International Paper Co., Ticonderoga
Wyeth Ayerst Laboratories, Rouses Point

Transportation

Highways: Two major interstate highways provide access. The eastern part of the region is served by the scenic Adirondack Northway, 1-87, which connects Albany and the New York State Thruway with Canada. 1-81 passes through the western part of the region connecting it with Syracuse and the New York State Thruway to the south and with major population and industrial centers to the north in Canada.

Air Service: Passenger service is provided at Watertown, Ogdensburg, Plattsburgh, Massena, and Saranac Lake.

Rail Service: Commercial rail service is provided by Conrail and Canadian Pacific; Amtrak operates passenger service on the eastern portion of the region from Montreal south to New York City.

Bus Service: Regular service is provided by Greyhound Bus Lines and Adirondack Trailways in several communities throughout the region.

Port Facilities: The Port of Ogdensburg provides deep-water port facilities for ocean-going vessels via the St. Lawrence Seaway, and many Northern New York businesses use the nearby Port of Montreal, the second-largest inland port in North America. The Champlain canal, part of the NewYork State Canal System, connects Lake Champlain and Montreal with the Hudson River and New York City, serving recreational as well as commercial users.

Education

Ten colleges and universities enroll close to 30,000 students, including two four-year colleges at Plattsburgh and Potsdam operated by the State University system. Clarkson University is home to the state's Center for Advanced Technology in Advanced Materials Processing.

Major Colleges and Universities Enrollment
Clarkson University, Potsdam 2,978
Paul Smith's College of Arts and Sciences 809
St. Lawrence University, Canton 1,983
SUNY College of Technology at Canton 2,278
SUNY College at Potsdam 4,562
SUNY College at Plattsburgh 6,160

Health Care

Champlain Valley Physicians Hospital, Plattsburgh
House of Good Samaritan Hospital, Watertown
A. Barton Hepburn Hospital, Ogdensburg
Adirondack Medical Center, Saranac Lake
Massena Memorial Hospital, Massena

Quality of Life

Northern New York is an area of outstanding physical beauty. Some natural attractions include the Thousand Islands in the St. Lawrence River, Ausable Chasm, the Adirondack Park and its 46 "high peaks," and Lake Champlain. The region is a four-season outdoor vacationland, with world-class alpine and nordic skiing, challenging hiking and backpacking, canoeing, kayaking, whitewater rafting, fishing and golf Lake Placid, site of the 1932 and 1980 Winter Olympics, is a major four season resort area. The Crane School of Music in Potsdam and the Remington Art Museum in Ogdensburg are two of the region's unique cultural offerings.

Prepared by NMPC, Syracuse New York - 1-800-944-6460

POTENTIAL STATE WIDE ALCOHOL PRODUCTION BASIS

MATERIAL COMPONENT	UNITS	CORN STOVER	GRASS	STRAW	PAPERMILL RESIDUE	CORN	BREWERY SOLIDS	CHEESE WHEY	SWEET CORN	CABBAGE	BEETS	SNAP BEANS	GRAPES	APPLE POMACE	CARROTS	PEAS	WINERY WASTE	CHERRIES	WILLOW BIOMASS
Production Rate	tons/yr	1,208,000	1,848,000	294,740	643,000	208,000	2,901,690	219,853	149,856	19,240	17,045	14,281	77,195	46,132	8,218	3,767	13,853	1,283	230
Percent Solids	%	85.00%	88.00%	85.00%	45.00%	89.00%	92.00%	7.00%	32.00%	7.60%	12.70%	9.00%	18.40%	89.00%	12.00%	17.00%	91.00%	18.40%	91.36%
Percent Water	%	15.00%	12.00%	15.00%	55.00%	11.00%	8.00%	93.00%	68.00%	92.40%	87.30%	91.00%	81.60%	11.00%	88.00%	83.00%	9.00%	81.60%	8.64%
Gallons of Alcohol		78,809,770	108,248,580	16,873,296	11,133,586	22,743,790	126,843,917	1,297,957	2,360,597	8,305	23,899	6,290	252,199	2,562,721	10,652	8,586	244,780	4,192	16,634
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SOLUBLE SOLIDS		74.47%	66.94%	74.00%	65.80%	95.30%	55.43%		54.40%										
Glucose (SS)	%	45.39%	37.87%	37.00%	49.70%	75.30%	27.86%	74.10%	43.25%	4.99%	9.70%	4.30%	15.60%	54.84%	9.49%	11.78%	17.06%	15.60%	52.32%
Xylose (SS)	%	23.86%	22.31%	24.00%	4.80%		15.03%												18.65%
Arabinose (SS)	%	2.00%	3.78%		0.70%		7.12%												1.89%
Other Sugars (SS)	%	1.11%	2.98%				2.33%												6.19%
Cellobiose (SS)	%																		
Glucose Oligomers (SS)	%																		
Xylose Oligomers (SS)	%																		
Other Oligomers (SS)	%																		
Acetate (SS)	%																		
OH	%																		
SO_4 (SS)	%																		
Others Soluble Solids	%	2.11%		13.00%	10.60%	20.00%	3.09%	15.60%	11.15%	1.49%	1.60%	2.00%	2.20%	8.90%	1.26%	3.52%	20.70%	2.20%	
INSOLUBLE SOLIDS		25.53%	33.06%	26.00%	34.20%	4.70%	44.57%	10.30%	45.60%										
Cellulose (IS)	%					2.00%			35.00%	0.80%	0.80%	1.15%	0.60%	17.52%	0.97%	1.11%	17.38%	0.60%	
Xylan (IS)	%																		
Arabinan (IS)	%																		
Other Sugar Polymers (IS)	%																		
Cellulase (IS)	%																		
Biomass (IS)	%																		
Zymo (IS)	%																		
Lignin (IS)	%	18.53%	25.29%	15.00%	29.30%	1.30%	40.48%		7.80%					15.87%			35.00%		20.47%
INORGANICS	%	7.00%	5.80%	11.00%	4.90%	1.40%	4.09%	10.30%	2.80%	0.70%	1.09%	1.95%	0.40%	2.70%	0.77%	1.07%	10.30%	0.40%	0.49%
Ca^{++} (IS)	%																		
Other Insoluble Solids	%																		
Carbon Dioxide	%																		
Methane	%																		
Oxygen	%																		
Nitrogen	%																		
Ammonia	%																		
Other Inorganic Ions	%		1.97%																
Total Potential Alcohol		371,449,751	gal/yr																

Note: Corn rate includes credit for DDGS replacement of Corn Grain as feed for dairy cows.

II. BIOMASS PLANT EVALUATION

A. GENERAL DISCUSSION

The simulation provided by NREL is the basis for evaluation of the biomass plant. Corn stover, hay and straw were the most promising feedstocks (see tables). The corn stover and grass feedstock characteristics were run in the simulation at 200,000 pounds per hour to bracket the plant around the three feedstocks. The results were very similar. A plant can be built to run 200,000 pounds per hour of these biomasses. It could be built to run 300,000 pounds per hour or more rather easily, the upper limit being dependent on the logistics of the biomass feedstock. The 200,000 pounds per hour rate was chosen to be used on a solids processing basis closely comparable to NREL's solids rate.

Based on the results, the economic evaluation should come very close to NREL's process economics. The cost estimate is conservative with a 25% contingency on total field and engineering costs, which is typical for this stage of project development. Cost offsets (deletions and additions) were made from NREL's cost estimate in feedstock storage and handling, fermentation, boiler, and generator costs. The feedstock storage and handling was redefined from a woodchip handling system (see NREL Process Description) to a bale handling system. Fermentation tank size was increased to a larger proven design that reduced the number of tanks. This increased the cost per tank, but resulted in overall cost reduction by reducing the number of tanks required. The boiler cost reduction is based on some preliminary discussions with a vendor. The increased steam turbine generator costs are based on a recent Raytheon project purchase. The cost offsets are a typical characteristic of a cost estimate as a project develops. It appears there maybe opportunities to reduce some other costs, but it is also too early to reduce the risk assessment of the 25% contingency for the current estimate.

Overall, the biomass plant appears feasible on a process basis. Further testing and evaluation of feedstocks and pilot plant test runs are needed for confirmation of the assumptions made in the simulation. Some of the areas for testing and evaluation are:

- The feedstock needs a more detailed chemical analysis for modeling in the simulation.
- The ash content of the feedstocks needs further definition.
- The feedstock needs to be test run in the shredder and hammermill to verify handling characteristics.
- Determine the final size requirements of the feed stock to be run through the process to optimize conversion rates and equipment requirements. Maybe we do not need the second reduction.
- The pilot plant run could also better define byproduct lignin and solids mixture characteristics, which are needed for better design of the evaporator and boiler. When these are done, further engineering can be done to refine the design.

An opportunity exists to find a commercial use and financial return on the CO_2, and sludge produced in the plant. This would improve economics. It has not been considered in the cost analysis.

Further engineering design could change certain equipment relationships resulting in either more or less space requirements for the plant.

B. OPTIMIZATION OPPORTUNITIES

Blowdown Tank Hydrolyzate Screw Conveyor

The screw conveyor can be replace by a pump.

Plant and Equipment Sizing

The size of the dry biomass material handling equipment seems to make the delivery systems run as units of 20,000,000 gallons of ethanol plant capacity. Maybe there are other areas that fit this pattern, such as the dehydration.

When looking at the fermentation, and after contact with a prominent tank manufacturer, the main fermentation could follow the same size pattern. By selecting the state of the art fermenter size, the capacity was met by 15 fermenters (13 required). This allowed cost savings by reducing the number of fermenters in spite of a slightly higher unit cost. Maybe the Seed Fermenters have a similar opportunity.

Lime Delivery and Storage

Lime delivery was proposed as railcar load lots. Based on the usage rate, this could be met by two railcars per year. A more reasonable delivery rate would be one tractor trailer delivery per month allowing for a smaller storage and less unloading equipment on site. Most hopper trailers have unloading systems on the trailer. The driver is then responsible to unload the trailer. This shifts capital to operating expense reducing the investment in the plant and the cost of labor.

Evaporator System

Previous experience in evaporator design has shown that the lignin streams in paper plants have been concentrated in evaporators to 75% to 80% solids for firing as liquids. The two-third effect bodies following a single second effect body appears strange. Closer examination of the system was not possible given the time and funding restrictions for this study. It was assumed that the number of evaporator bodies and the heat balance are correct. There would seem to be cost reduction opportunities here.

Boiler

Boilers have fired liquid lignin streams before. It would appear to be easier and less capital intensive to fire the solid by-products as a part of the liquid lignin stream. The biosolids in this plant are not generally abrasive. With attention given to this area in preliminary engineering for a commercial plant, this should be easily realizable.

There is a cost break in the boiler at 1100 PSIG operating pressure. The boiler was priced as readily available catalogue standard, 900 PSIG operating pressure, with burner and fire box modifications to fire natural gas and liquid by-product. There are similar 900 PSIG systems currently used in co-generation in agricultural plants

Gas firing is needed to startup the plant before by-product fuel becomes available. Furthermore, the natural gas flame should be maintained at some yet to be determined rate to insure ignition and combustion of the by-product. Based on previous experience, a 5 MMBTU rate for each furnace was selected for the cost model.

Water Balance

There is a mass balance warning and a water warning on the splitter for the process condensate flows for the plant. It appears the model is normalizing the split based on a predetermined flow requirement, which is not met. With the change to the biomass water content, the plant may be short of water. A more in-depth analysis is needed. Allowance for extra water was made in the cost analysis because the amount of funding does not allow further study within the budget and schedule.

Infrastructure

Because of the size of this plant, total truck removal/delivery of the alcohol produced is not practical, nor is the delivery of all the enzyme needed for the fermentation. The utilization of railcars for the alcohol removal/delivery is very necessary. The onsite manufacture of enzymes is very cost effective relative to transportation costs (per vendor discussions).

Operating Costs

Enzyme cost is very difficult to predict subject to a negotiated licensing arrangement with a supplier, or other development in enzymes. Generally, purchasing enzymes will have a very negative impact on plant profitability. Several corn wet milling companies produce their own enzymes independent from any major enzyme manufacturer.

Material of Construction for Acid Hydrolysis Reactor

As requested, materials of construction were checked for the paper plant digesters. Most recent systems are not acid based, which allows for carbon steel construction. The acid based systems use stainless type materials. Glass lined vessels are not known to be used. The glass would tend to cause problems in some applications, if it found its way into the pulp stock.

There are other opportunities not mentioned or examined because of time and budget constraints.

C. PROCESS DESCRIPTION

Introduction

This 60,000,000-gallon per year plant is based on processing 200,000 pounds per hour of baled straw, hay, or corn stover feed stock. The feedstock characteristics are as shown in the attached Feed Stock Composition Data Sheet. The process is based on the National Renewable Energy Laboratory (NREL) Aspen simulation r9901f, design database, and process descriptions.

The following description is only intended to provide an overview with details about the biomass feed handling system. As previously mentioned, the process is based on NREL's simulation and process design for wood chips. The design and simulation did not contain a developed biomass feed handling system. The following is a more detailed description of the biomass feed handling system. The process receives square baled field crop residues. The bales are shredded and chopped to ¾ inch size pieces for processing.

Biomass Feed Handling

The biomass handling and delivery system approach focused on utilizing existing equipment expected to be found on the farm. After a short discussion with Ron Robbins, it was determined to focus on flat bed truck delivery of square bales loaded by farmers. Both round and square bales are produced, and shredded on a small scale for animal feed. It was determined that the farmer does not have sufficient shredding equipment to pre-shred biomass for delivery. Square bales are easier to truck than round bales. And square bales are easier to convey and feed to the shredder.

The shredded and chopped biomass is not expected to exhibit free flow characteristics making truck and storage bin unloading troublesome. Furthermore, the sized biomass is very low density, which does not work well with certain types of equipment, like bucket elevators.

Deliveries of material are planned to be accepted five (5) days per week except holidays, whether it rains, snows, or shines, starting at 7 a.m. The biomass will be received at the plant in square bales of approximate dimensions of 32" X 32" x 7 feet long loaded long axis parallel to the long axis of a standard flat bed truck (45'L x 8'W x 52"H). These loads comprise 54 bales (3 high, 3 wide, and 6 long) and need to be covered to preclude moisture uptake from direct water impacts. Each bale weighs approximately 600, 750, or 900 pounds at acceptable moisture levels, depending on the material, straw, hay, or corn stover (biomass), respectively. Each truckload of material is weighed in, sampled for moisture, unloaded, and weighed out in less than an hour. No mixed truckloads of material are accepted. Loads will be scheduled by logistics supervisors to smooth the flow and ensure continuous plant operation. Seasonal runs of hay, straw, and corn stover are expected.

After weighing and sampling has been completed, the delivery trucks are marshaled in a waiting area to be driven along either side of the three (3) bale conveyors, as open spots become available. The each bale conveyor has four (4) truck spots for unloading. Each bale conveyor has two (2) unloading cranes that each unloads one truck at a time at a rate of one (1) bale every 30 seconds. Thus, the equivalent plant bale unloading rate is one bale every 15 seconds on each bale conveyor on two 8 hour shifts, for up to 11,520 bales per day. Based on preliminary vendor data on a readily available crane, a crane should be able to move a bale from the truck to the bale conveyor in less than 20 seconds over the longest traveled path. Allowing 10 seconds extra (50% more) travel time provides plenty of buffer to realize moving one bale every 30 seconds from the flat bed truck to the bale conveyor.

Each bale conveyor is the first piece of equipment of a processing subsystem that moves the biomass from truck to surge storage to acid hydrolysis. The individual subsystems comprise:

A bale conveyor
A bale shredder feeder
A bale shredder (- 4 inch)
A shredded biomass take-away conveyor
A destoner with tramp metal magnet
A hammermill (-3/4 inch)
A pneumatic storage fill conveyor
A storage bin
A bin unloader
A bin unloader screw conveyor
A pneumatic process feed conveyor to wetting tank
An acid hydrolysis tank feed pump
A acid hydrolysis tank
A flash tank feed pump

At the flash tank, all three systems merge to the rest of the plant described by NREL.

Each conveyor unloading system is capable of 240 bales per hour. This is 433,200 pounds per hour for straw, 504,000 pounds per hour for hay, or 648,000 pounds per hour for corn stover, if only one kind of material is handled. These rates will provide varying degrees of buffer from 2.2 days to 5.8 days for each five-day operational period. The shorter buffer times are during the summer months.

Biomass Surge Storage

Each storage bin retrieval system can operate at either 67,000 or 100,000 pounds per hour to provide full capacity with either 3 or 2 subsystems operating, respectively, for on-line maintenance time. Thus, a whole subsystem including the bin can be emptied and shutdown for maintenance, as well as provide for interruption of service due to unforeseen circumstances without impacting plant capacity.

To reach the solids delivery rate for straw, three (3) bale subsystems need to be unloading at the same time. If there were an unscheduled maintenance shutdown for pure straw delivery, straw delivery could be scheduled to include Saturday to make up the difference. Assuming straw delivery only during the warm months, the amount of surge storage required could be reduced since snow delays are not likely. Separate unloading lines could run different materials, for instance, two (2) hay and one (1) straw.

Biomass delivery needs can be met at an average rate of 214 trucks, one truck every 4 to 5 minutes (13.3 per hour), per 16 hour day. There will be other truck deliveries and all trucks will not arrive on a precise schedule. It is estimated that biomass truck traffic alone could approach 240 vehicles a day.

Fermentation Slurry Preparation

After the dry material is retrieved from storage, it is wetted and acid hydrolyzed at high temperature and pressure to break down the long chain cellulose fibers and the naturally occurring acetate groups bound to the cellulose. Then, the slurry is steamed flashed to further break apart the fibrous cellulose. The recovered slurry is then separated into a liquid stream and a wet solids stream. The liquids are sent to ion exchange for reduction of acetic acid and overlimed for reduction of other impurities that are toxic impediments to the fermentation. The liquid and solids are then recombined to reform a prepared slurry. The slurry preparation results in a pH adjusted, properly diluted, and conditioned feed stock for fermentation that has retained most free sugars or starch intermediates produced during this prehydrolysis.

Fermentation

The conditioned fermentation slurry stream is then split and sent to the main fermenters, the cellobiase enzyme production fermenters, and the cellulase enzyme production fermenters.

The cellulase enzyme and cellobiase enzymes are produced on site rather than transported to the site to reduce costs because of the volume needed to support the plant. The two enzymes work together for Simultaneous Saccharification and Co-Fermentation (SSCF) production of alcohol in the main fermenters.

The fermentations are based on wood chip to alcohol research studies done by NREL over the last few years. Wood chips are known to vary from corn stover, grasses, and straw in the amount of lignin contained in the biomass. The fermentation produces a typical beer with alcohol and unreacted solids in a water solution.

Product Recovery and Water Separation

The beer produced in fermentation is further processed in the typical distillation, dehydration, and evaporation system utilized in current alcohol product plants. A two-column distillation and dehydration is used for production of fuel grade ethanol. The ethanol is denatured by adding unleaded gasoline and the fusel oil byproduct. Water, lignin and solids are recovered from the bottom of the beer still. The solids and lignin are concentrated by evaporation into an evaporator syrup for firing in the boiler. The condensed water vapor from the evaporator is sent to waste water treatment for biogas development.

Waste Water Treatment

The water recovered from the distillation, dehydration and evaporation is treated in an anaerobic digester, aerobic digester, and clarification/filtration plant. The processed water can be recycled to the plant. A sludge byproduct is produced, which is disposed of. The anaerobic digester produces a medium BTU value off-gas that is fired in the boiler for process steam and power production.

Boiler and Cogeneration

The boiler has several functions. It produces steam for processing needs, disposes of the concentrated evaporator syrup, and produces byproduct power. The evaporator syrup contains unconverted lignin, which can be burned to produce power and alleviate a disposal problem.

The boiler burner is multi-fuel capable with natural gas for start-up, liquid evaporator syrup for thermal oxidation of lignin and unprocessed solids, and biogas for additional energy recovery. There is sufficient energy contained in the byproduct streams to produce more steam than is needed by the process. This energy is recovered as co-generated electrical power by producing high-pressure steam and reducing the steam pressure to process conditions through a steam turbine driven generator. Sufficient power is produced to run the plant and have an excess to sell for revenue.

Utilities And Other Bulk Feed Materials

The process is supported by bulk chemical storage for process needs and other utilities. Storage for lime, ammonia, corn steep liquor, sulfuric acid, antifoam gasoline, and water treatment chemicals are provided. These various chemicals are received by rail or truck, in addition to, the truck receipt of baled dry biomass.

D. PROCESS PLANT SUMMARY CONSTRUCTION COST ESTIMATE

There are two estimates presented here, one with onsite production of enzymes and one without. Two enzymes manufacturing companies were contacted. They both stated that large users produce their enzymes on site or very near by. Some produce them under license and some do not. For the size of this plant, on site production has cost advantages from transportation as well as logistics advantages from reduced truck traffic.

The two cost estimates are made by ratioing the equipment prices to produce the other estimate breakout costs. These ratios are based on similar work at other alcohol plants and other agricultural projects. Caution should be exercised when comparing the different ratios to other projects, to compare equivalent ratios. Special consideration should be given to the following:

- The equipment price contains subcontracted, field erected tanks costed on per gallon rates including labor. The labor split may not compare readily to other estimates.
- The true contingency rate is 25.9% of the Total Field Cost and Home Office subtotals.
- Field staff can vary according to contracting procedures
- CM Fee can generally vary between 1% and 5% depending on risks assigned to the Construction Manager. It can even be higher depending on process guarantees.
- Start-up, testing and training can vary depending on the staffing plan. Inexperienced people raise this cost.
- The contingency can be assumed to be spent on the project at this level of details for minor items not included in the equipment list, unknown equipment requirements, unknown site requirements, and other unidentified costs.

The estimate does not include offsite roads, railroads, and utility connections. These will vary according to site location.

This estimate is believed to be sufficiently accurate for the feasibility study based on the information known. It can be used to evaluate the RCBS site as well as any non-specific site.

Raytheon Engineers & Constructors

CLIENT: NYSTEC
PROJECT: 60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
LOCATION: NEW YORK
JOB NO.: 78849.001

MID AMERICA / CHICAGO OFFICE

DATE : 19-Jul-99
PRICED BY : PMF
REV. NO. :

RE&C ACCT	DESCRIPTION	MANHOURS	LABOR	MATERIAL	SUBS	TOTAL	% TOTAL	% TOTAL '06'	% TOTAL TFC & H.O.
01	IMPROVEMENTS TO SITE		$505,600	$758,400		$1,264,000	0.5%	2.0%	0.7%
02	EARTHWORK		$2,099,600	$2,008,400		$4,108,000	1.8%	6.5%	2.3%
03	CONCRETE		$5,498,400	$4,614,600		$10,113,000	4.4%	16.0%	5.7%
05	STRUCTURAL STEEL		$3,635,700	$3,051,300		$6,687,000	2.9%	23.0%	3.8%
06	PROCESS EQUIPMENT		$7,021,850	$56,184,150		$63,206,000	27.4%	100.0%	35.5%
21	PIPING		$15,465,000	$13,610,000		$29,075,000	12.6%	46.0%	16.3%
23	INSULATION		$1,961,200	$1,830,800		$3,792,000	1.6%	6.0%	2.1%
24	INSTRUMENTATION & CONTROLS		$5,169,000	$13,793,000		$18,962,000	8.2%	30.0%	10.7%
25	ELECTRICAL		$6,585,600	$4,159,400		$10,745,000	4.7%	17.0%	6.0%
27	PAINTING		$1,017,400	$878,600		$1,896,000	0.8%	3.0%	1.1%
40	BUILDINGS & ARCHITECTURAL		$0		$9,481,000	$9,481,000	4.1%	15.0%	5.3%
	DIRECT FIELD COST	0	$48,959,350	$100,888,650	$9,481,000	$159,329,000	69.2%	264.5%	89.6%
69	START-UP, TESTING AND TRAINING					Excluded	0.0%	0.0%	0.0%
70	TEMPORARY FACILITIES					Included Above	0.0%	0.0%	0.0%
70	CONSTRUCTION EQUIPMENT, TOOLS, SUPPLIES					Included Above	0.0%	0.0%	0.0%
71	FIELD STAFF AND LEGALITIES					$4,677,000	2.0%	7.4%	2.6%
	INDIRECT FIELD COST	0	$0	$0	$0	$4,677,000	2.0%	7.4%	2.6%
	TOTAL FIELD COST	0	$48,959,350	$100,888,650	$9,481,000	$164,006,000	71.2%	271.9%	92.2%
72	ENGINEERING (HOME OFFICE)					$13,906,000	6.0%	22.0%	7.8%
	TOTAL FIELD AND HOME OFFICE					$177,912,000	77.2%	293.9%	100.0%
	TAXES (Assume Tax Exempt Project)					$0	0.0%	0.0%	0.0%
	INSURANCE					$1,011,296	0.4%	1.6%	0.6%
	PERMITS					$94,809	0.0%	0.2%	0.1%
	CRAFT CASUAL OVERTIME					$506,000	0.2%	0.8%	0.3%
	CONTINGENCY					$46,140,000	20.0%	73.0%	25.9%
	ESCALATION (Excluded)					$0	0.0%	0.0%	0.0%
	SUBTOTAL					$225,664,105	98.0%	369.5%	126.8%
	CM FEE					$4,680,000	2.0%	7.4%	2.6%
	TOTAL (CONSTRUCTION COSTS THROUGH MECHANICAL COMPLETION)					$230,344,105	100.0%	376.9%	129.5%

Please note that the cost estimates provided herein are dependent upon the basis of the quantities and pricing utilized to develop them, and upon the underlying assumptions, inclusions, and exclusions. Actual Project costs will differ, and can significantly affected by changes in the external environment, the manner in which the projects implemented, and other factors which impact the basis upon which the initial estimate was prepared or otherwise affect the project. Estimate accuracy ranges are projections based upon cost estimating methods and practices in accordance with ordinary standards of care normally practiced by recognized engineering firms in performing services of a similar nature. They are not a guarantee of actual project costs.

Raytheon Engineers & Constructors

CLIENT: NYSTEC
PROJECT: 60 MM GAL/YR BIOMASS TO ETHANOL (No Enzyme Production)
LOCATION: NEW YORK
JOB NO.: 78849.001

MID AMERICA / CHICAGO OFFICE

DATE : 19-Jul-99
PRICED BY : PMF
REV. NO. :

RE&C ACCT	DESCRIPTION	MANHOURS	LABOR	MATERIAL	SUBS	TOTAL	% TOTAL	% TOTAL '06'	% TOTAL TFC & H.O.
01	IMPROVEMENTS TO SITE		$466,000	$699,000		$1,165,000	0.5%	2.0%	0.7%
02	EARTHWORK		$1,935,000	$1,851,000		$3,786,000	1.8%	6.5%	2.3%
03	CONCRETE		$5,066,700	$4,252,300		$9,319,000	4.4%	16.0%	5.7%
05	STRUCTURAL STEEL		$3,350,300	$2,811,700		$6,162,000	2.9%	23.0%	3.8%
06	PROCESS EQUIPMENT		$6,470,850	$51,771,150		$58,242,000	27.4%	100.0%	35.5%
21	PIPING		$14,250,100	$12,540,900		$26,791,000	12.6%	46.0%	16.3%
23	INSULATION		$1,807,600	$1,687,400		$3,495,000	1.6%	6.0%	2.1%
24	INSTRUMENTATION & CONTROLS		$4,763,100	$12,709,900		$17,473,000	8.2%	30.0%	10.7%
25	ELECTRICAL		$6,068,300	$3,832,700		$9,901,000	4.7%	17.0%	6.0%
27	PAINTING		$937,400	$809,600		$1,747,000	0.8%	3.0%	1.1%
40	BUILDINGS & ARCHITECTURAL		$0		$8,736,000	$8,736,000	4.1%	15.0%	5.3%
	DIRECT FIELD COST	0	$45,115,350	$92,965,650	$8,736,000	$146,817,000	69.2%	264.5%	89.6%
69	START-UP, TESTING AND TRAINING					Excluded	0.0%	0.0%	0.0%
70	TEMPORARY FACILITIES					Included Above	0.0%	0.0%	0.0%
70	CONSTRUCTION EQUIPMENT, TOOLS, SUPPLIES					Included Above	0.0%	0.0%	0.0%
71	FIELD STAFF AND LEGALITIES					$4,310,000	2.0%	7.4%	2.6%
	INDIRECT FIELD COST	0	$0	$0	$0	$4,310,000	2.0%	7.4%	2.6%
	TOTAL FIELD COST	0	$45,115,350	$92,965,650	$8,736,000	$151,127,000	71.2%	271.9%	92.2%
72	ENGINEERING (HOME OFFICE)					$12,814,000	6.0%	22.0%	7.8%
	TOTAL FIELD AND HOME OFFICE					$163,941,000	77.2%	293.9%	100.0%
	TAXES (Assume Tax Exempt Project)					$0	0.0%	0.0%	0.0%
	INSURANCE					$931,872	0.4%	1.6%	0.6%
	PERMITS					$87,363	0.0%	0.2%	0.1%
	CRAFT CASUAL OVERTIME					$466,000	0.2%	0.8%	0.3%
	CONTINGENCY					$42,517,000	20.0%	73.0%	25.9%
	ESCALATION (Excluded)					$0	0.0%	0.0%	0.0%
	SUBTOTAL					$207,943,235	98.0%	369.5%	126.8%
	CM FEE					$4,310,000	2.0%	7.4%	2.6%
	TOTAL (CONSTRUCTION COSTS THROUGH MECHANICAL COMPLETION)					$212,253,235	100.0%	376.9%	129.5%

Please note that the cost estimates provided herein are dependent upon the basis of the quantities and pricing utilized to develop them, and upon the underlying assumptions, inclusions, and exclusions. Actual Project costs will differ, and can significantly affected by changes in the external environment, the manner in which the projects implemented, and other factors which impact the basis upon which the initial estimate was prepared or otherwise affect the project. Estimate accuracy ranges are projections based upon cost estimating methods and practices in accordance with ordinary standards of care normally practiced by recognized engineering firms in performing services of a similar nature. They are not a guarantee of actual project costs.

E. PRICED EQUIPMENT LIST

The priced equipment list is comprised of extrapolation of equipment sizes and quantities from the NREL database for the simulations run; changes to the receiving, storage and processing of the biomass up to the flash vessel; changes to the alcohol fermenter size and quantity; changes to the refrigeration capacity; and changes to the boiler and steam turbine generator. The cost estimates for the changed equipment are based on vendor quotes (written and verbal), similar equipment on very recent projects, and cost-escalated estimates on less recent equipment (not more than 3 years old). There are two estimated cost columns. The first is a unit price, and the next is a quantity price.

No discounts were taken for quantity orders. The horsepower column has listed sizes that do not match standard motor sizes. These are not errors and are not special motors. These are summations of the expected connected motor horsepower around that particular piece(s) of equipment. The sum of the equipment horsepower has not been adjusted for utilization factor, so that there is a contingency, in the total applied horsepower used for power consumption, and electrical utility consumption costs.

The structures are not estimated as equipment, but shown for definition. The cost of the structures is in the different accounts of steel, concrete, etc.

This plant equipment cost can be misleading when comparisons are made on a cost per horsepower basis because of the tankage.

There are opportunities for cost reduction in the equipment in tankage and alternate equipment.

Rev. A , 7/22/99

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
		RECEIVING, SHREDDING, & GRINDING								
2	M- 101	Biomass Truck Scale	10					$66,000	$132,000	AAG
3	M- 100	Bale Probe						$8,000	$24,000	AAG
6	M- 102	Bale Overhead Tramrail Crane	10	CS	15.75		32 ft span x 1000 lb lift x 100 ft run w/clamps,C	$65,000	$390,000	QUOTE
3	C- 103	48" wide Bale Belt Conveyor	10	CS	120		Flat belt conv 400 ft lg w/cont skirts & covers	$170,000	$510,000	ESTIMATE
3	C- 103	Bale Discharger	10	CS	6		to push 600# to 800# bale into shredder	$5,000	$15,000	ESTIMATE
3	M- 105	Primary Bale Shredder, 3" to 4" lumps	10	CS	750		Model ST-200EL, 43" x 96" chamber, 2,400 #	$275,000	$825,000	QUOTE
1	C- 106A	36" wide Shred Belt Conveyor	10	CS	20		Trough belt conv x 185 ft lg w/load skirts	$88,000	$88,000	ESTIMATE
1	C- 106B	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 145 ft lg w/load skirts	$67,500	$67,500	ESTIMATE
1	C- 106C	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 125 ft lg w/load skirts	$59,500	$59,500	ESTIMATE
3	M- 104	Magnets	10	SS				$30,000	$90,000	ESTIMATE
3	C- 107	Destoners	10	SS	9			$40,000	$120,000	ESTIMATE
3	M- 108	Shred Hammermill, -3/4" lumps @ 18 pcf	10	CS	750		Model HM44-48 @ 2,400 #/min, 12pcf	$80,000	$240,000	QUOTE
		STORAGE								
3	C- 109	Pneumatic Conveying Blowers to Storage	10	CS	375		Model LS33UB, 20,200 CFM @ 17" SP	$45,000	$135,000	QUOTE
1	C- 110	Pneumatic Conveying Piping	10	CS			30" dia x 840 LF w/(12) 90 deg bends		INC.	ESTIMATE
3	BN- 110	Shred Storage Bins, 267,000 cu ft Capac	10	CS	24		78 ft dia x 72 ft high mild steel	$323,000	$969,000	QUOTE
3	S- 101	H2O Tank Filter Receiver w/ Airlock	10	CS/SS	92		20,200 CFM	$130,000	$390,000	ESTIMATE
3	S- 111	Shred Storage Dust Coll. w/ Airlock, Scre	10	CS	92		20,200 CFM	$120,000	$360,000	ESTIMATE
3	S- 111	Shred Storage Bin Cyclone Receiver w/A	10	CS	6		20,200 CFM	$120,000	$360,000	ESTIMATE
3	C- 111	Shred Storage Bin Internal Unloader	10	CS	304.5		Hyd, 2 speed 100,000#/hr or 67,000#/hr @ 18	$260,000	$780,000	QUOTE
3	C- 112	Shred Storage Reclaim Screw Convs.	10	CS	60		20" dia x 75 ft lg, 2 speed, 67,000 or 100,000#	$25,000	$75,000	QUOTE
3	C- 113	Pneu. Conveying Blowers to H2O Tank	10	CS	375		Model LS29UB, 20,200 CFM @ 17" SP	$45,000	$135,000	QUOTE
								Subtotal	$5,765,000	
		STRUCTURES								
3		Belt Conveyor Str Stl Trusses & Bents		CS			For the (3) Bale Belt Conveyors			
1		Shredders & Belt Convs Support		Precast			For the (3) Shredded Hay Belt Conveyors			
1		Support for (3) Hammermills		CS						
1		Pneu. Conv Lines Tower Support		CS			With stairway to top			
3		Hori. Truss Walkway to Storage Bins		CS			For the (3) pneumatic conveying lines			
1		Storage Bin Foundations		Reinf. Conc.			Mat fdn w/tunnels for (3) reclaim screw convs			
3		Overhead Tramrail Crane Supports		CS			To accommodate (6) tramrail cranes			
1		Weather Cover for Tramrail Cranes		CS			To cover a 100 ft x 150 ft structure			
		PREHYDROLYSIS								
3	A- 203	In-Line Sulfuric Acid Mixer	20	304 SS	NA		STATIC	$3,500	$10,500	CORN
1	A- 215	In-Line NH3 Mixer	20	304 SS	NA		STATIC	$3,500	$3,500	CORN
1	P- 206	Hydrolyzate Pump	20	316 SS	50			$40,000	$40,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
1	C- 209	Wash Solids Screw Conveyor	20	304 SS	20				$62,000	$62,000	NREL EXTRAP.
2	H- 207	Beer Column Feed Economizers	20	304 SS	NA			SHELL & TUBE	$135,000	$270,000	NREL EXTRAP.
1	H- 211	Hydrolyzate Cooler	20	304 SS / CS	NA			SHELL & TUBE	$30,000	$30,000	NREL EXTRAP.
3	T- 204D	Biomass Wetting Tank	20	304SS	NA				$4,000	$12,000	ESTIMATE
3	T- 204G	Prehydrolysis Reactor	20	HAST C	NA			SCREW FEEDER	$12,000	$36,000	ESTIMATE
3	P- 202	Sulfuric Acid Pump	20	304 SS	1			CENTRIFUGAL	$12,000	$36,000	NREL EXTRAP.
1	P- 210	ISEP Hydrolyzate Feed Pump	20	304 SS	50			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 213	ISEP Reload Pump	20	304 SS	30			CENTRIFUGAL	$6,000	$6,000	NREL EXTRAP.
1	P- 214	ISEP Elution Pump	20	304 SS	10			CENTRIFUGAL	$5,500	$5,500	NREL EXTRAP.
3	S- 208	Pre-IX Belt Filter Press	20	316 SS	22.5				$1,100,000	$3,300,000	NREL EXTRAP.
1	S- 212	ISEP	20	316 SS/ PP	NA			CONTINUOUS	$1,400,000	$1,400,000	NREL EXTRAP.
1	T- 216	ISEP Feed Tank	20	304SS	NA			Not shown, Part of S-208	$6,000	$6,000	ESTIMATE
1	T- 201	Sulfuric Acid Day Tank	20	PP	NA	3,200	GAL	VERTCAL, CYLINDRICAL	$4,000	$4,000	NREL EXTRAP.
1	T- 206	Blowdown Tank	20	316 SS	NA	7,200	GAL	VERTICAL, CYLINDRICAL	$42,000	$42,000	NREL EXTRAP.
		OVERLIMING							Subtotal	$5,270,500	
1	A- 217	In-Line Acidification Mixer	21	304 SS	NA			STATIC	$3,500	$3,500	NREL EXTRAP.
1	A- 222	Overliming Tank Agitator	21	SS	25			FIXED PROP	$15,000	$15,000	NREL EXTRAP.
1	A- 225	Reacidification Tank Agitator	21	SS	100			FIXED PROP	$22,000	$22,000	NREL EXTRAP.
1	A- 230	Slurrying Tank Agitator	21	SS	50			FIXED PROP	$15,000	$15,000	NREL EXTRAP.
1	C- 219	Lime Solids Feeder	21	CS	5			ROTARY VALVE	$1,500	$1,500	NREL EXTRAP.
1	P- 223	Overlimed Hydrolyzate Pump	21	304 SS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 226	Reacidified Liquor Pump	21	304 SS	50			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 228	Filtered Hydrolyzate Pump	21	304 SS	75			CENTRIFUGAL	$7,500	$7,500	NREL EXTRAP.
3	P- 231	Fermentation Feed Pumps	21	304 SS	300			ROTARY LOBE	$40,000	$120,000	NREL EXTRAP.
1	S- 220	Lime Dust Vent Baghouse	21	CS/POLY	NA			FABRIC FILTER	$32,000	$32,000	NREL
1	S- 227	Hydroclone & Rotary Drum Filter	21	POXY LINED	5				$110,000	$110,000	NREL EXTRAP.
1	T- 218	Lime Storage Bin	21	CS	NA	4500	CF	VERTICAL, CYLINDRICAL	$70,000	$70,000	NREL
1	T- 221	Overliming Tank	21	304 SS	NA	23,000	GAL	VERTICAL, CYLINDRICAL	$52,000	$52,000	NREL EXTRAP.
1	T- 224	Reacidification Tank	21	304 SS	NA	95,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$100,000	$100,000	NREL EXTRAP.
1	T- 229	Slurrying Tank	21	304 SS	NA	12,500	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$30,000	$30,000	NREL EXTRAP.
		SEED FERMENTATION							Subtotal	$592,500	
3	A- 308	4th Seed Fermenter Agitator	30	SS	60			FIXED PROP	$8,000	$24,000	NREL EXTRAP.
3	A- 309	5th Seed Fermenter Agitator	30	SS	60			FIXED PROP	$7,000	$21,000	NREL EXTRAP.
3	A- 322	SSCF Seed Hold Tank Agitator	30	304 SS	75			FIXED PROP	$8,000	$24,000	CORN
3	F- 301	1st SSCF Seed Fermenter	30	304 SS	NA	10	GAL	VERTICAL, CYLINDRICAL	$4,500	$13,500	NREL EXTRAP.
3	F- 302	2nd SSCF Seed Fermenter	30	304 SS	NA	100	GAL	VERTICAL, CYLINDRICAL	$8,000	$24,000	NREL EXTRAP.
3	F- 303	3rd SSCF Seed Fermenter	30	304 SS	NA	1000	GAL	VERTICAL, CYLINDRICAL	$26,000	$78,000	NREL EXTRAP.
3	F- 304	4th SSCF Seed Fermenter	30	304 SS	NA	10,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$80,000	$240,000	NREL EXTRAP.

Project 78849.001
NYSTEC

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
3	F- 305	5th SSCF Seed Fermenter	30	304 SS	NA	100,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$150,000	$450,000	CORN
3	H- 306	4th Seed Fermenter Coil	30	SS	NA			IMMERSED	$2,500	$7,500	NREL EXTRAP.
3	H- 307	5th Seed Fermenter Coil	30	SS	NA			IMMERSED	$15,000	$45,000	NREL EXTRAP.
3	H- 320	SSCF Seed Hydrolyzate Cooler	30	304 SS	NA			PLATE & FRAME	$10,000	$30,000	NREL EXTRAP.
3	P- 323	SSCF Seed Transfer Pump	30	304 SS	180			ROTARY LOBE	$15,000	$45,000	NREL EXTRAP.
3	P- 324	Seed Transfer Pump	30	304 SS	180			ROTARY LOBE	$35,000	$105,000	NREL EXTRAP.
3	T- 321	SSCF Seed Hold Tank	30	304 SS	NA	130,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$110,000	$330,000	NREL EXTRAP.
		FERMENTATION							Subtotal	$1,437,000	
1	A- 338	Beer Storage Tank Agitator	31	304 SS	20			FIXED PROP	$50,000	$50,000	NREL EXTRAP.
15	A- 300	SSCF Fermenter Agitators	31	304 SS	3000			FIXED PROP	$50,000	$750,000	CORN
15	F- 300	SSCF Fermenters	31	304 SS	NA	1,267,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$519,470	$7,792,050	CORN EXTRAP.
3	H- 336	SSCF Hydrolyzate Coolers	31	304 SS	NA			PLATE & FRAME	$16,000	$48,000	NREL EXTRAP.
15	H- 300	Fermenter Coolers	31	304 SS	NA			INTERNAL COILS	$50,000	$750,000	CORN
1	P- 339	Beer Transfer Pump	31	304 SS	150			CENTRIFUGAL	$12,000	$12,000	NREL EXTRAP.
15	P 300	SSCF Recirculation & Transfer Pumps	31	304 SS	1125			CENTRIFUGAL	$12,000	$180,000	CORN
1	T- 337	Beer Storage Tank	31	304 SS	NA	8,000	GAL	VERICAL, CYLINDRICAL, FLAT BOTTOM	$24,000	$24,000	NREL EXTRAP.
		CELLULASE SEED PRODUCTION							Subtotal	$9,606,050	
3	F- 401	1st Cellulase Seed Fermenter	40	304 SS	NA	20	GAL	VERTICAL, CYLINDRICAL	$4,500	$13,500	NREL EXTRAP.
3	F- 402	2nd Cellulase Seed Fermenter	40	304 SS	NA	330	GAL	VERTICAL, CYLINDRICAL	$26,000	$78,000	NREL EXTRAP.
3	F- 403	3rd Cellulase Seed Fermenter	40	304 SS	NA	6,600	GAL	VERTICAL, CYLINDRICAL	$30,000	$90,000	NREL EXTRAP.
3	P 404	Cellulase Seed Pump	40	316 SS	1			ROTARY LOBE	$8,000	$24,000	NREL EXTRAP.
		CELLULASE PRODUCTION							Subtotal	$205,500	
11	A- 421	Cellulase Fermenter Agitator	41	304 SS	5500			AXIAL IMPELLER	$50,000	$550,000	NREL EXTRAP.
11	F- 410	Cellulase Fermenter	41	304 SS	NA	264,000	GAL	VERTICAL, CYLINDRICAL	$175,000	$1,925,000	CORN EXTRAP.
11	H- 432	Cellulase Fermenter Cooler	41	304 SS	NA			IMMERSED COIL	$23,000	$253,000	NREL EXTRAP.
1	P- 406	Media Pump	41	SS	1			CENTRIFUGAL	$5,500	$5,500	NREL EXTRAP.
1	P- 408	Antifoam Pump	41	CS	1			CENTRIFUGAL	$4,000	$4,000	NREL EXTRAP.
1	P- 409	Cellulase Transfer Pump	41	SS	110			CENTRIFUGAL	$6,500	$6,500	NREL EXTRAP.
1	T- 405	Media Prep Tank	41	304 SS	NA	3,200	GAL	VERTICAL, CYLINDRICAL	$24,000	$24,000	NREL EXTRAP.
1	T- 407	Antifoam Tank	41	PE	NA	500	GAL	VERTICAL, CYLINDRICAL	$2,500	$2,500	NREL EXTRAP.
		DISTILLATION & RECTIFICATION							Subtotal	$2,770,500	
1	D- 502	Beer Column	50	304 SS	NA			DISTILLATION	$204,000	$204,000	CORN
1	D- 510	Rectification Column	50	SS	NA			DISTILLATION	$360,000	$360,000	CORN
1	H- 501	Beer Column Feed Interchange	50	SS	NA			PLATE & FRAME	$95,000	$95,000	CORN
1	H- 504	Beer Column Reboiler	50	304 SS / CS	NA			SHELL & TUBE	$165,000	$165,000	CORN
1	H- 507	Beer Column Condenser	50	304 SS / CS	NA			SHELL & TUBE	$137,000	$137,000	CORN
1	H- 508	Rectification Column Reboiler	50	304 SS / CS	NA			SHELL & TUBE	$20,000	$20,000	CORN
1	H- 513	Rectification Column Condenser	50	304 SS / CS	NA			SHELL & TUBE	$60,000	$60,000	NREL EXTRAP.
1	P- 503	Beer Column Bottoms Pump	50	SS	400			CENTRIFUGAL	$29,000	$29,000	CORN

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
1	P- 506	Beer Column Reflux Pump	50	SS	1			CENTRIFUGAL	$6,000	$6,000	CORN
1	P- 509	Rectification Column Bottoms Pump	50	SS	15			CENTRIFUGAL	$7,000	$7,000	CORN
1	P- 512	Rectification Column Reflux Pump	50	SS	25			CENTRIFUGAL	$6,000	$6,000	CORN
1	P- 515	Scrubber Bottoms Pump	50	SS	5			CENTRIFUGAL	$2,000	$2,000	NREL EXTRAP.
1	T- 505	Beer Column Reflux Drum	50	304 SS	NA	175	GAL	HORIZONTAL, CYLINDRICAL	$8,000	$8,000	NREL EXTRAP.
1	T- 511	Rectification Column Reflux Drum	50	304 SS / CS	NA			HORIZONTAL, CYLINDRICAL	$23,000	$23,000	CORN
1	T- 514	Vent Scrubber	50	304 SS / Poly	NA			ABSORBER	$30,000	$30,000	CORN
		EVAPORATION & DEHYDRATION							Subtotal	$1,152,000	
1	E- 520	1st Effect Evaporator(2)	51	316 SS				SHELL & TUBE	$1,750,000	$1,750,000	CORN
1	E- 525	2nd Effect Evaporator	51	316 SS				SHELL & TUBE	w / E-520A		CORN
1	E- 530	3rd Effect Evaporator(2)	51	316 SS				SHELL & TUBE	w / E-520A		CORN
1	H- 532	Evaporator Condenser	51	304 SS / CS				SHELL & TUBE	w / E-520A		CORN
3	M- 516	Molecular Sieve	51	SS					$800,000	$2,400,000	CORN
2	P- 521	1st Effect Pump	51	SS	500			CENTRIFUGAL	w / E-520A		CORN
1	P- 526	2nd Effect Pump	51	SS	75			CENTRIFUGAL	w / E-520A		CORN
2	P- 531	3rd Effect Pump	51	SS	100			CENTRIFUGAL	w / E-520A		CORN
1	P- 533	Evaporator Condensate Pump	51	304 SS / CS	50			CENTRIFUGAL	w / E-520A		CORN
		LIGNIN SEPARATION							Subtotal	$4,150,000	
1	A- 604	Recycled Water Tank Agitator	60	SS	10			FIXED PROP	$8,000	$8,000	CORN
1	C- 602	Lignin Wet Cake Screw	60	CS	25				$21,000	$21,000	NREL EXTRAP.
2	P- 605	Recycled Water Pump	60	CS	120			CENTRIFUGAL	$6,000	$12,000	CORN
4	S- 601	Beer Column Bottoms Centrifuge	60	316 SS	320			CENTRIFUGAL	$600,000	$2,400,000	CORN
1	T- 603	Recycled Water Tank	60	CS	NA			VERTICAL, CYLINDRICAL, FLAT BOTTOM	$10,000	$10,000	NREL EXTRAP.
		WASTE WATER TREATMENT							Subtotal	$2,451,000	
4	A- 608	Equalization Basin Agitator	61	SS	160			FIXED PROP	$19,000	$76,000	NREL EXTRAP.
4	A- 613	Anaerobic Agitator	61	SS	160			FIXED PROP	$20,000	$80,000	NREL EXTRAP.
16	A- 617	Aerobic Lagoon Agitator	61	CS	400			SURFACE AERATOR	$350,000	$5,600,000	NREL EXTRAP.
1	C- 625	Aerobic Sludge Screw	61	CS	5				$4,000	$4,000	NRELEXTRAP.
1	H- 610	Anaerobic Digestor Feed Cooler	61	316 SS / CS	NA			SHELL & TUBE	$85,000	$85,000	NREL EXTRAP.
1	M- 611	Nutrient Feed System	61	CS	5				$22,000	$22,000	NREL EXTRAP.
1	M- 615	Biogas Emergency Flare	61	SS	NA				$12,000	$12,000	NREL EXTRAP.
1	P- 609	Anaerobic Reactor Feed Pump	61	CS	30			CENTRIFUGAL	$8,000	$8,000	NREL EXTRAP.
1	P- 614	Aerobic Digestor Feed Pump	61	CS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 618	Aerobic Digestion Outlet Pump	61	CS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 619	Aerobic Sludge Recycle Pump	61	316 SS	2			SLURRY	$7,500	$7,500	NREL EXTRAP.
1	P- 621	Aerobic Sludge Pump	61	316 SS	2			SLURRY	$7,500	$7,500	NREL EXTRAP.
1	P- 622	Treated Water Pump	61	CS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 626	Sludge Filtrate Recycle Pump	61	CS	2			CENTRIFUGAL	$4,000	$4,000	NREL EXTRAP.
1	S- 624	Belt Filter Press	61		30				$75,000	$75,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
1	T- 607	Equalization Basin	61	CONCRETE	NA				$225,000	$225,000	NREL EXTRAP.
1	T- 612	Anaerobic Digestor	61	POXY LINED	NA			VERTICAL, CYLINDRICAL, FLAT BOTTOM	$350,000	$350,000	NREL EXTRAP.
1	T- 616	Aerobic Digestor (4)	61	LYMER LINE	NA			LINED PIT	$425,000	$425,000	NREL EXTRAP.
1	T- 620	Clarifier	61	CONCRETE	NA				$120,000	$120,000	NREL EXTRAP.
		LIQUID STORAGE							Subtotal	$7,122,000	
1	A- 703	Denaturant In-Line Mixer	70	304 SS	NA			STATIC	$3,500	$3,500	CORN
2	P- 702	Ethanol Product Pump	70	CS	5			CENTRIFUGAL	$5,500	$11,000	CORN
1	P- 705	Gasoline Pump	70	CS	2			CENTRIFUGAL	$4,000	$4,000	CORN
1	P- 709	Sulfuric Acid Pump	70	316 SS	1			CENTRIFUGAL	$2,000	$2,000	CORN
1	P- 711	Firewater Pump	70	CS	200			CENTRIFUGAL	$16,000	$16,000	NREL EXTRAP.
1	P- 713	Ammonia Pump	70	CS	1			CENTRIFUGAL	$3,500	$3,500	NREL EXTRAP.
1	P- 715	Antifoam Store Pump	70	CS	1			CENTRIFUGAL	$4,000	$4,000	NREL EXTRAP.
1	P- 717	CSL Pump	70	CS	5			CENTRIFUGAL	$6,000	$6,000	NREL EXTRAP.
1	T- 701	Ethanol Product Storage Tank	70	A285C	NA	300,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$400,000	$400,000	CORN
1	T- 704	Gasoline Storage Tank	70	A285C	NA	60,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$95,000	$95,000	CORN
1	T- 708	Sulfuric Acid Storage Tank	70	PP	NA	9,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$9,000	$9,000	CORN
1	T- 710	Firewater Storage Tank	70	A285C	NA	300,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$110,000	$110,000	NREL EXTRAP.
1	T- 712	Ammonia Storage Tank	70	A515	NA	58,000	GAL	HORIZONTAL, CYLINDRICAL	$200,000	$200,000	NREL EXTRAP.
1	T- 714	Antifoam Storage Tank	70	A285C	NA	12,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$12,000	$12,000	NREL EXTRAP.
1	T- 716	CSL Storage Tank	70	304 SS	NA	36,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$60,000	$60,000	NREL EXTRAP.
		BOILER & GENERATOR							Subtotal	$936,000	
2	H- 803	Burner Combustion Air Preheater	80		NA				$400,000	$800,000	NREL EXTRAP.
2	H- 806	BFW Preheater	80	285C / A214	NA			SHELL & TUBE	$12,000	$24,000	NREL EXTRAP.
2	M- 801	Fluidized Bed Combustion Reactor	80	CS	NA				$1,600,000	$3,200,000	NREL EXTRAP.
2	M- 802	Combustion Air Fan	80	CS	500			CENTRIFUGAL	$22,000	$44,000	NREL EXTRAP.
1	M- 804	Turbine/Generator	80		NA				$6,000,000	$6,000,000	NREL EXTRAP.
2	M- 807	Combustion Gas Baghouse	80	85C / FABRI	30			FABRIC FILTER	$500,000	$1,000,000	NREL EXTRAP.
2	P- 805	Turbine Condensate Pump	80	CS	50			CENTRIFUGAL	$2,000	$4,000	NREL EXTRAP.
		BOILER FEED WATER							Subtotal	$11,072,000	
2	M- 810	Condensate Polisher	81		NA				$70,000	$140,000	NREL EXTRAP.
2	M- 811	Demineralizer	81		NA				$140,000	$280,000	NREL EXTRAP.
1	M- 820	Hydrazine Addition Package	81		1				$13,000	$13,000	NREL EXTRAP.
1	M- 825	Ammonia Addition Package	81		1				$13,000	$13,000	NREL EXTRAP.
1	M- 830	Phosphate Addition Package	81		1				$13,000	$13,000	NREL EXTRAP.
2	P- 809	Condensate Pump	81	CS	20			CENTRIFUGAL	$5,500	$11,000	NREL EXTRAP.
2	P- 813	Deaerator Feed Pump	81	CS	15			CENTRIFUGAL	$2,300	$4,600	NREL EXTRAP.
2	P- 815	BFW Pump	81	CS	1200			CENTRIFUGAL	$140,000	$280,000	NREL EXTRAP.
2	P- 817	Blowdown Pump	81	CS	1			CENTRIFUGAL	$3,000	$6,000	NREL EXTRAP.
1	P- 819	Hydrazine Transfer Pump	81	CS	1			CENTRIFUGAL	$1,500	$1,500	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITH ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
1	T- 808	Condensate Collection Tank	81	A285C				VERTICAL, CYLINDRICAL	$4,500	$4,500	NREL EXTRAP.
1	T- 812	Condensate Surge Drum	81	CS				HORIZONTAL, CYLINDRICAL	$16,000	$16,000	NREL EXTRAP.
1	T- 814	Deaerator	81	A515				HORIZONTAL, CYLINDRICAL	$10,000	$10,000	NREL EXTRAP.
1	T- 816	Blowdown Flash Drum	81	CS				HORIZONTAL, CYLINDRICAL	$5,000	$5,000	NREL EXTRAP.
1	T- 818	Hydrazine Drum	81	316 SS				VERTICAL, CYLINDRICAL	$6,500	$6,500	NREL EXTRAP.
		CHILLED, COOLING, & PROCESS WATER							Subtotal	$804,100	
1	M- 901	Cooling Tower System	90	IBERGLASS	150			INDUCED DRAFT	$800,000	$800,000	NREL EXTRAP.
1	M- 903	Chilled Water Package	90	CS	300			CENTRIFUGAL	$250,000	$250,000	NREL EXTRAP.
2	P- 902	Cooling Water Pump	90	CS	300			CENTRIFUGAL	$50,000	$100,000	
2	P- 904	Make-up Water Pump	90	CS	300			CENTRIFUGAL	$7,000	$14,000	NREL EXTRAP.
2	P- 906	Process Water Circulating Pump	90	CS	200			CENTRIFUGAL	$7,500	$15,000	NREL EXTRAP.
1	T- 905	Process Water Tank	90	CS	NA	400,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$130,000	$130,000	NREL EXTRAP.
		CIP							Subtotal	$1,309,000	
1	M- 907	CIP System	91	CS	100				$80,000	$80,000	
		COMPRESSED AIR									
2	M- 908	Plant Air Compressor	92	CS	300			RECIPROCATING	$87,000	$174,000	CORN
2	M- 911	Fermenter Air Filters	92	CS	NA			CENTRIFUGAL	$16,000	$32,000	NREL EXTRAP.
1	S- 909	Instrument Air Dryer	92	CS	NA				$15,000	$15,000	CORN
1	T- 910	Plant Air Receiver	92	CS	NA			HORIZONTAL, CYLINDRICAL	$40,000	$40,000	CORN
				Est. Total Hp	20,713	15,431	KW				
1		Chutes & Ducts Allowances							$1,200,000	$1,200,000	CORN
			Est. Misc. Plant Power			1,069	KW		Subtotal	$1,541,000	
			Est. Total Power Usage			16,500	KW		TOTAL	$56,184,150	

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITHOUT ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity	Misc.	Estimated Cost	Estimated Cost	Basis
		RECEIVING, SHREDDING, & GRINDING								
2	M- 100	Biomass Truck Scale	10					$66,000	$132,000	AAG
3	M- 101	Bale Probe						$8,000	$24,000	AAG
6	M- 102	Bale Overhead Tramrail Crane	10	CS	15.75		32 ft span x 1000 lb lift x 100 ft run w/clamps,C	$65,000	$390,000	QUOTE
3	C- 103	48" wide Bale Belt Conveyor	10	CS	120		Flat belt conv 400 ft lg w/cont skirts & covers	$170,000	$510,000	ESTIMATE
3	M- 104	Bale Discharger	10	CS	6		to push 600# to 800# bale into shredder	$5,000	$15,000	ESTIMATE
3	M- 105	Primary Bale Shredder, 3" to 4" lumps	10	CS	750		Model ST-200EL, 43" x 96" chamber, 2,400 #	$275,000	$825,000	QUOTE
1	C- 106	36" wide Shred Belt Conveyor	10	CS	20		Trough belt conv x 185 ft lg w/load skirts	$88,000	$88,000	ESTIMATE
1	C- 106	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 145 ft lg w/load skirts	$67,500	$67,500	ESTIMATE
1	C- 106	36" wide Shred Belt Conveyor	10	CS	15		Trough belt conv x 125 ft lg w/load skirts	$59,500	$59,500	ESTIMATE
3	M- 107	Magnets	10	SS				$30,000	$90,000	ESTIMATE
3	S- 108	Destoners	10	SS	9			$40,000	$120,000	ESTIMATE
3	M- 109	Shred Hammermill, -3/4" lumps @ 18 pcf	10	CS	750		Model HM44-48 @ 2,400 #/min, 12pcf	$80,000	$240,000	QUOTE
		STORAGE								
3	C- 110	Pneumatic Conveying Blowers to Storage	10	CS	375		Model LS33UB, 20,200 CFM @ 17" SP	$45,000	$135,000	QUOTE
1	C- 110	Pneumatic Conveying Piping	10	CS			30" dia x 840 LF w/(12) 90 deg bends		INC.	ESTIMATE
3	T- 111	Shred Storage Bins, 267,000 cu ft Capac	10	CS	24		78 ft dia x 72 ft high mild steel	$323,000	$969,000	QUOTE
3	S- 101	H2O Tank Filter Receiver w/ Airlock	10	CS/SS	92		20,200 CFM	$130,000	$390,000	ESTIMATE
3	S- 111	Shred Storage Dust Coll. w/ Airlock, Scre	10	CS	92		20,200 CFM	$120,000	$360,000	ESTIMATE
3	S- 111	Shred Storage Bin Cyclone Receiver w/A	10	CS	6		20,200 CFM	$120,000	$360,000	ESTIMATE
3	C- 112	Shred Storage Bin Internal Unloader	10	CS	304.5		Hyd, 2 speed 100,000#/hr or 67,000#/hr @ 18	$260,000	$780,000	QUOTE
3	C- 113	Shred Storage Reclaim Screw Convs.	10	CS	60		20" dia x 75 ft lg, 2 speed, 67,000 or 100,000#	$25,000	$75,000	QUOTE
3	C- 114	Pneu. Conveying Blowers to H2O Tank	10	CS	375		Model LS29UB, 20,200 CFM @ 17" SP	$45,000	$135,000	QUOTE
								Subtotal	$5,765,000	
		STRUCTURES								
3		Belt Conveyor Str Stl Trusses & Bents		CS			For the (3) Bale Belt Conveyors			
1		Shredders & Belt Convs Support		Precast			For the (3) Shredded Hay Belt Conveyors			
1		Support for (3) Hammermills		CS						
1		Pneu. Conv Lines Tower Support		CS			With stairway to top			
3		Hori. Truss Walkway to Storage Bins		CS			For the (3) pneumatic conveying lines			
1		Storage Bin Foundations		Reinf. Conc.			Mat fdn w/tunnels for (3) reclaim screw convs			
3		Overhead Tramrail Crane Supports		CS			To accommodate (6) tramrail cranes			
1		Weather Cover for Tramrail Cranes		CS			To cover a 100 ft x 150 ft structure			
		PREHYDROLYSIS								
3	A- 203	In-Line Sulfuric Acid Mixer	20	304 SS	NA		STATIC	$3,500	$10,500	CORN
1	A- 215	In-Line NH3 Mixer	20	304 SS	NA		STATIC	$3,500	$3,500	CORN
1	P- 206	Hydrolyzate Pump	20	316 SS	50			$40,000	$40,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITHOUT ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
1	C- 209	Wash Solids Screw Conveyor	20	304 SS	20				$62,000	$62,000	NREL EXTRAP.
2	H- 201	Beer Column Feed Economizers	20	304 SS	NA			SHELL & TUBE	$135,000	$270,000	NREL EXTRAP.
1	H- 211	Hydrolyzate Cooler	20	304 SS / CS	NA			SHELL & TUBE	$30,000	$30,000	NREL EXTRAP.
3	T- 202	Biomass Wetting Tank	20	304SS	NA				$4,000	$12,000	ESTIMATE
3	T- 202	Prehydrolysis Reactor	20	HAST C	NA			SCREW FEEDER	$12,000	$36,000	ESTIMATE
3	P- 201	Sulfuric Acid Pump	20	304 SS	1			CENTRIFUGAL	$12,000	$36,000	NREL EXTRAP.
1	P- 210	ISEP Hydrolyzate Feed Pump	20	304 SS	50			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 213	ISEP Reload Pump	20	304 SS	30			CENTRIFUGAL	$6,000	$6,000	NREL EXTRAP.
1	P- 214	ISEP Elution Pump	20	304 SS	10			CENTRIFUGAL	$5,500	$5,500	NREL EXTRAP.
3	S- 208	Pre-IX Belt Filter Press	20	316 SS	22.5				$1,100,000	$3,300,000	NREL EXTRAP.
1	S- 212	ISEP	20	316 SS/ PP	NA			CONTINUOUS	$1,400,000	$1,400,000	NREL EXTRAP.
1	T- 216	ISEP Feed Tank	20	304SS	NA				$6,000	$6,000	ESTIMATE
1	T- 201	Sulfuric Acid Day Tank	20	PP	NA	3,200	GAL	VERTCAL, CYLINDRICAL	$4,000	$4,000	NREL EXTRAP.
1	T- 203	Blowdown Tank	20	316 SS	NA	7,200	GAL	VERTICAL, CYLINDRICAL	$42,000	$42,000	NREL EXTRAP.
		OVERLIMING							Subtotal	$5,270,500	
1	A- 217	In-Line Acidification Mixer	21	304 SS	NA			STATIC	$3,500	$3,500	NREL EXTRAP.
1	A- 222	Overliming Tank Agitator	21	SS	25			FIXED PROP	$15,000	$15,000	NREL EXTRAP.
1	A- 225	Reacidification Tank Agitator	21	SS	100			FIXED PROP	$22,000	$22,000	NREL EXTRAP.
1	A- 230	Slurrying Tank Agitator	21	SS	50			FIXED PROP	$15,000	$15,000	NREL EXTRAP.
1	C- 219	Lime Solids Feeder	21	CS	5			ROTARY VALVE	$1,500	$1,500	NREL EXTRAP.
1	P- 223	Overlimed Hydrolyzate Pump	21	304 SS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 226	Reacidified Liquor Pump	21	304 SS	50			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 228	Filtered Hydrolyzate Pump	21	304 SS	75			CENTRIFUGAL	$7,500	$7,500	NREL EXTRAP.
3	P- 231	Fermentation Feed Pumps	21	304 SS	300			ROTARY LOBE	$40,000	$120,000	NREL EXTRAP.
1	S- 220	Lime Dust Vent Baghouse	21	CS/POLY	NA			FABRIC FILTER	$32,000	$32,000	NREL
1	S- 227	Hydroclone & Rotary Drum Filter	21	POXY LINED	5				$110,000	$110,000	NREL EXTRAP.
1	T- 218	Lime Storage Bin	21	CS	NA	4500	CF	VERTICAL, CYLINDRICAL	$70,000	$70,000	NREL
1	T- 221	Overliming Tank	21	304 SS	NA	23,000	GAL	VERTICAL, CYLINDRICAL	$52,000	$52,000	NREL EXTRAP.
1	T- 224	Reacidification Tank	21	304 SS	NA	95,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$100,000	$100,000	NREL EXTRAP.
1	T- 229	Slurrying Tank	21	304 SS	NA	12,500	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$30,000	$30,000	NREL EXTRAP.
		FERMENTATION							Subtotal	$592,500	
1	A- 338	Beer Storage Tank Agitator	31	304 SS	20			FIXED PROP	$50,000	$50,000	NREL EXTRAP.
15	A- 300	SSCF Fermenter Agitators	31	304 SS	3000			FIXED PROP	$50,000	$750,000	CORN
15	F- 300	SSCF Fermenters	31	304 SS	NA	1,267,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$519,470	$7,792,050	CORN EXTRAP.
3	H- 336	SSCF Hydrolyzate Coolers	31	304 SS	NA			PLATE & FRAME	$16,000	$48,000	NREL EXTRAP.
15	H- 300	Fermenter Coolers	31	304 SS	NA			INTERNAL COILS	$50,000	$750,000	CORN
1	P- 339	Beer Transfer Pump	31	304 SS	150			CENTRIFUGAL	$12,000	$12,000	NREL EXTRAP.
15	P 300	SSCF Recirculation & Transfer Pumps	31	304 SS	1125			CENTRIFUGAL	$12,000	$180,000	CORN
1	T- 337	Beer Storage Tank	31	304 SS	NA	8,000	GAL	VERICAL, CYLINDRICAL, FLAT BOTTOM	$24,000	$24,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITHOUT ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
									Subtotal	$9,606,050	
		DISTILLATION & RECTIFICATION									
1	D- 502	Beer Column	50	304 SS	NA			DISTILLATION	$204,000	$204,000	CORN
1	D- 510	Rectification Column	50	SS	NA			DISTILLATION	$360,000	$360,000	CORN
1	H- 501	Beer Column Feed Interchange	50	SS	NA			PLATE & FRAME	$95,000	$95,000	CORN
1	H- 504	Beer Column Reboiler	50	304 SS / CS	NA			SHELL & TUBE	$165,000	$165,000	CORN
1	H- 507	Beer Column Condenser	50	304 SS / CS	NA			SHELL & TUBE	$137,000	$137,000	CORN
1	H- 508	Rectification Column Reboiler	50	304 SS / CS	NA			SHELL & TUBE	$20,000	$20,000	CORN
1	H- 513	Rectification Column Condenser	50	304 SS / CS	NA			SHELL & TUBE	$60,000	$60,000	NREL EXTRAP.
1	P- 503	Beer Column Bottoms Pump	50	SS	400			CENTRIFUGAL	$29,000	$29,000	CORN
1	P- 506	Beer Column Reflux Pump	50	SS	1			CENTRIFUGAL	$6,000	$6,000	CORN
1	P- 509	Rectification Column Bottoms Pump	50	SS	15			CENTRIFUGAL	$7,000	$7,000	CORN
1	P- 512	Rectification Column Reflux Pump	50	SS	25			CENTRIFUGAL	$6,000	$6,000	CORN
1	P- 515	Scrubber Bottoms Pump	50	SS	5			CENTRIFUGAL	$2,000	$2,000	NREL EXTRAP.
1	T- 505	Beer Column Reflux Drum	50	304 SS	NA	175	GAL	HORIZONTAL, CYLINDRICAL	$8,000	$8,000	NREL EXTRAP.
1	T- 511	Rectification Column Reflux Drum	50	304 SS / CS	NA			HORIZONTAL, CYLINDRICAL	$23,000	$23,000	CORN
1	T- 514	Vent Scrubber	50	304 SS / Poly	NA			ABSORBER	$30,000	$30,000	CORN
									Subtotal	$1,152,000	
		EVAPORATION & DEHYDRATION									
1	E- 520	1st Effect Evaporator(2)	51	316 SS				SHELL & TUBE	$1,750,000	$1,750,000	CORN
1	E- 525	2nd Effect Evaporator	51	316 SS				SHELL & TUBE	w / E-520A		CORN
1	E- 530	3rd Effect Evaporator(2)	51	316 SS				SHELL & TUBE	w / E-520A		CORN
1	H- 532	Evaporator Condenser	51	304 SS / CS				SHELL & TUBE	w / E-520A		CORN
3	M- 516	Molecular Sieve	51	SS					$800,000	$2,400,000	CORN
2	P- 521	1st Effect Pump	51	SS	500			CENTRIFUGAL	w / E-520A		CORN
1	P- 526	2nd Effect Pump	51	SS	75			CENTRIFUGAL	w / E-520A		CORN
2	P- 531	3rd Effect Pump	51	SS	100			CENTRIFUGAL	w / E-520A		CORN
1	P- 533	Evaporator Condensate Pump	51	304 SS / CS	50			CENTRIFUGAL	w / E-520A		CORN
									Subtotal	$4,150,000	
		LIGNIN SEPARATION									
1	A- 604	Recycled Water Tank Agitator	60	SS	10			FIXED PROP	$8,000	$8,000	CORN
1	C- 602	Lignin Wet Cake Screw	60	CS	25				$21,000	$21,000	NREL EXTRAP.
2	P- 605	Recycled Water Pump	60	CS	120			CENTRIFUGAL	$6,000	$12,000	CORN
4	S- 601	Beer Column Bottoms Centrifuge	60	316 SS	320			CENTRIFUGAL	$600,000	$2,400,000	CORN
1	T- 603	Recycled Water Tank	60	CS	NA			VERTICAL, CYLINDRICAL, FLAT BOTTOM	$10,000	$10,000	NREL EXTRAP.
									Subtotal	$2,451,000	
		WASTE WATER TREATMENT									
4	A- 608	Equalization Basin Agitator	61	SS	160			FIXED PROP	$19,000	$76,000	NREL EXTRAP.
4	A- 613	Anaerobic Agitator	61	SS	160			FIXED PROP	$20,000	$80,000	NREL EXTRAP.
16	A- 617	Aerobic Lagoon Agitator	61	CS	400			SURFACE AERATOR	$350,000	$5,600,000	NREL EXTRAP.
1	C- 625	Aerobic Sludge Screw	61	CS	5				$4,000	$4,000	NRELEXTRAP.
1	H- 610	Anaerobic Digestor Feed Cooler	61	316 SS / CS	NA			SHELL & TUBE	$85,000	$85,000	NREL EXTRAP.
1	M- 611	Nutrient Feed System	61	CS	5				$22,000	$22,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITHOUT ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
1	M- 615	Biogas Emergency Flare	61	SS	NA				$12,000	$12,000	NREL EXTRAP.
1	P- 609	Anaerobic Reactor Feed Pump	61	CS	30			CENTRIFUGAL	$8,000	$8,000	NREL EXTRAP.
1	P- 614	Aerobic Digestor Feed Pump	61	CS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 618	Aerobic Digestion Outlet Pump	61	CS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 619	Aerobic Sludge Recycle Pump	61	316 SS	2			SLURRY	$7,500	$7,500	NREL EXTRAP.
1	P- 621	Aerobic Sludge Pump	61	316 SS	2			SLURRY	$7,500	$7,500	NREL EXTRAP.
1	P- 622	Treated Water Pump	61	CS	75			CENTRIFUGAL	$7,000	$7,000	NREL EXTRAP.
1	P- 626	Sludge Filtrate Recycle Pump	61	CS	2			CENTRIFUGAL	$4,000	$4,000	NREL EXTRAP.
1	S- 624	Belt Filter Press	61		30				$75,000	$75,000	NREL EXTRAP.
1	T- 607	Equalization Basin	61	CONCRETE	NA				$225,000	$225,000	NREL EXTRAP.
1	T- 612	Anaerobic Digestor	61	POXY LINED	NA			VERTICAL, CYLINDRICAL, FLAT BOTTOM	$350,000	$350,000	NREL EXTRAP.
1	T- 616	Aerobic Digestor	61	LYMER LINE	NA			LINED PIT	$425,000	$425,000	NREL EXTRAP.
1	T- 620	Clarifier	61	CONCRETE	NA				$120,000	$120,000	NREL EXTRAP.
		LIQUID STORAGE							Subtotal	$7,122,000	
1	A- 703	Denaturant In-Line Mixer	70	304 SS	NA			STATIC	$3,500	$3,500	CORN
2	P- 702	Ethanol Product Pump	70	CS	5			CENTRIFUGAL	$5,500	$11,000	CORN
1	P- 705	Gasoline Pump	70	CS	2			CENTRIFUGAL	$4,000	$4,000	CORN
1	P- 709	Sulfuric Acid Pump	70	316 SS	1			CENTRIFUGAL	$2,000	$2,000	CORN
1	P- 711	Firewater Pump	70	CS	200			CENTRIFUGAL	$16,000	$16,000	NREL EXTRAP.
1	P- 713	Ammonia Pump	70	CS	1			CENTRIFUGAL	$3,500	$3,500	NREL EXTRAP.
1	P- 715	Antifoam Store Pump	70	CS	1			CENTRIFUGAL	$4,000	$4,000	NREL EXTRAP.
1	P- 717	CSL Pump	70	CS	5			CENTRIFUGAL	$6,000	$6,000	NREL EXTRAP.
1	T- 701	Ethanol Product Storage Tank	70	A285C	NA	300,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$400,000	$400,000	CORN
1	T- 704	Gasoline Storage Tank	70	A285C	NA	60,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$95,000	$95,000	CORN
1	T- 708	Sulfuric Acid Storage Tank	70	PP	NA	9,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$9,000	$9,000	CORN
1	T- 710	Firewater Storage Tank	70	A285C	NA	300,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$110,000	$110,000	NREL EXTRAP.
1	T- 712	Ammonia Storage Tank	70	A515	NA	58,000	GAL	HORIZONTAL, CYLINDRICAL	$200,000	$200,000	NREL EXTRAP.
1	T- 714	Antifoam Storage Tank	70	A285C	NA	12,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$12,000	$12,000	NREL EXTRAP.
1	T- 716	CSL Storage Tank	70	304 SS	NA	36,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$60,000	$60,000	NREL EXTRAP.
		BOILER & GENERATOR							Subtotal	$936,000	
2	H- 803	Burner Combustion Air Preheater	80		NA				$400,000	$800,000	NREL EXTRAP.
2	H- 806	BFW Preheater	80	285C / A214	NA			SHELL & TUBE	$12,000	$24,000	NREL EXTRAP.
2	M- 801	Fluidized Bed Combustion Reactor	80	CS	NA				$1,600,000	$3,200,000	NREL EXTRAP.
2	M- 802	Combustion Air Fan	80	CS	500			CENTRIFUGAL	$22,000	$44,000	NREL EXTRAP.
1	M- 804	Turbine/Generator	80		NA				$6,000,000	$6,000,000	NREL EXTRAP.
2	M- 807	Combustion Gas Baghouse	80	85C / FABRI	30			FABRIC FILTER	$500,000	$1,000,000	NREL EXTRAP.
2	P- 805	Turbine Condensate Pump	80	CS	50			CENTRIFUGAL	$2,000	$4,000	NREL EXTRAP.
		BOILER FEED WATER							Subtotal	$11,072,000	
2	M- 810	Condensate Polisher	81		NA				$70,000	$140,000	NREL EXTRAP.

EQUIPMENT LIST
60 MM GAL/YR BIOMASS TO ETHANOL FACILITY
WITHOUT ENZYME FERMENTATION

Qty	Equip No.	Equipment Name	FD	Mat'l Of Const	Est. HP	Capacity		Misc.	Estimated Cost	Estimated Cost	Basis
2	M- 811	Demineralizer	81		NA				$140,000	$280,000	NREL EXTRAP.
1	M- 820	Hydrazine Addition Package	81		1				$13,000	$13,000	NREL EXTRAP.
1	M- 825	Ammonia Addition Package	81		1				$13,000	$13,000	NREL EXTRAP.
1	M- 830	Phosphate Addition Package	81		1				$13,000	$13,000	NREL EXTRAP.
2	P- 809	Condensate Pump	81	CS	20			CENTRIFUGAL	$5,500	$11,000	NREL EXTRAP.
2	P- 813	Deaerator Feed Pump	81	CS	15			CENTRIFUGAL	$2,300	$4,600	NREL EXTRAP.
2	P- 815	BFW Pump	81	CS	1200			CENTRIFUGAL	$140,000	$280,000	NREL EXTRAP.
2	P- 817	Blowdown Pump	81	CS	1			CENTRIFUGAL	$3,000	$6,000	NREL EXTRAP.
1	P- 819	Hydrazine Transfer Pump	81	CS	1			CENTRIFUGAL	$1,500	$1,500	NREL EXTRAP.
1	T- 808	Condensate Collection Tank	81	A285C				VERTICAL, CYLINDRICAL	$4,500	$4,500	NREL EXTRAP.
1	T- 812	Condensate Surge Drum	81	CS				HORIZONTAL, CYLINDRICAL	$16,000	$16,000	NREL EXTRAP.
1	T- 814	Deaerator	81	A515				HORIZONTAL, CYLINDRICAL	$10,000	$10,000	NREL EXTRAP.
1	T- 816	Blowdown Flash Drum	81	CS				HORIZONTAL, CYLINDRICAL	$5,000	$5,000	NREL EXTRAP.
1	T- 818	Hydrazine Drum	81	316 SS				VERTICAL, CYLINDRICAL	$6,500	$6,500	NREL EXTRAP.
		CHILLED, COOLING, & PROCESS WATER							Subtotal	$804,100	
1	M- 901	Cooling Tower System	90	IBERGLASS	150			INDUCED DRAFT	$800,000	$800,000	NREL EXTRAP.
1	M- 903	Chilled Water Package	90	CS	300			CENTRIFUGAL	$250,000	$250,000	NREL EXTRAP.
2	P- 902	Cooling Water Pump	90	CS	300			CENTRIFUGAL	$50,000	$100,000	
2	P- 904	Make-up Water Pump	90	CS	300			CENTRIFUGAL	$7,000	$14,000	NREL EXTRAP.
2	P- 906	Process Water Circulating Pump	90	CS	200			CENTRIFUGAL	$7,500	$15,000	NREL EXTRAP.
1	T- 905	Process Water Tank	90	CS	NA	400,000	GAL	VERTICAL, CYLINDRICAL, FLAT BOTTOM	$130,000	$130,000	NREL EXTRAP.
		CIP							Subtotal	$1,309,000	
1	M- 907	CIP System	91	CS	100				$80,000	$80,000	
		COMPRESSED AIR									
2	M- 908	Plant Air Compressor	92	CS	300			RECIPROCATING	$87,000	$174,000	CORN
2	M- 911	Fermenter Air Filters	92	CS	NA			CENTRIFUGAL	$16,000	$32,000	NREL EXTRAP.
1	S- 909	Instrument Air Dryer	92	CS	NA				$15,000	$15,000	CORN
1	T- 910	Plant Air Receiver	92	CS	NA			HORIZONTAL, CYLINDRICAL	$40,000	$40,000	CORN
				Est. Total Hp	14,545	10,836	KW				
1		Chutes & Ducts Allowances							$1,200,000	$1,200,000	CORN
			Est. Misc. Plant Power			1,069	KW		Subtotal	$1,541,000	
			Est. Total Power Usage			11,905	KW		TOTAL	$51,771,150	

F. PLANT OPERATING COST ESTIMATES

There is only one plant operating cost and revenue sheet assembled with the biomass price from NREL acknowledged by Ron Robbins as reasonable (however, hay currently sells for about $100/ton according to published data). The estimated labor costs, other overhead percentages, and chemical costs are recent values used in other projects (Fall, 1998). The selected alcohol market price was chosen to be very competitive. The costs for electricity and natural gas are subject to negotiations (see attached Internet printouts). The electrical sale price used for co-generated electricity is generally recognized as reasonable. However, Niagara Mohawk phone quoted $0.062 for the first 450 KW, then $0.044 per KW thereafter. Maybe it is that low, but I am skeptical about other fees and contract arrangements. Natural gas was also quoted as $2,500 for the first 5,000 therms, then $0.40 per therm thereafter. It becomes more reasonable to use a lot of natural gas.

The cost of enzymes are particularly troublesome. Two major enzyme companies that were contacted have not yet considered how they would supply or charge enzymes for this type of plant. They do not currently supply any similar plants. One initial response of 5 to 10 times the cost of enzymes for a grain to ethanol plant, on a cost per gallon of ethanol produced basis, indicates this plant will need to manufacture its own enzymes by buying nursery stock from some source.

This is not unusual. There are several alcohol producers that do not buy commercial enzymes for their plants. They produce their own.

The cost of operating supplies, chemicals, and lubricants will be area specific and vendor deal dependent.

The plant maintenance cost will be plant design and equipment specific. The plant is designed to control corrosion.

There are opportunities on lime costs for a small on-site limekiln, if prices are too high, as long as a near by, proper quality, limestone quarry is available.

If a well is used, the cost of water will differ.

Other agricultural processing plants have avoided landfill costs by selling their sludge.

ESTIMATED OPERATING COSTS AND REVENUES

ANNUAL OPERATING COSTS WITH ENZYME FERMENTATION			
Biomass	840,000 tons/year	$35.00 /ton (Note 1)	$29,400,000
Labor			$6,537,450
Operating Supplies			$445,000
Maintenance Materials			$1,966,200
Lubricants			$10,000
Laboratory Chemicals			$96,000
Operating Chemicals			
H2SO4	4,170 pounds/hr	$0.03	$108
Lime	1,764 pounds/hr	$75.00	$555,660
NH3	1,530 pounds/hr	$0.11	$1,349,460
CSL	2 tons/hr	$25.00	$434,910
Nutrients	383 pounds/hr	$0.12	$47
NH4SO4	863 pounds/hr	$0.02	$19
Antifoam	12 pounds/hr	$0.24	$24,192
Gasoline	369 gal/hr	$0.60	$1,859,760
Water	257 cu.ft./hr	$0.67	$1,446,396
Natural Gas	100 therms/hr	$1.86	$1,562,400
BFW Chemicals	2 pounds/hr	$0.97	$17,926
CW Chemicals	11 pounds/hr	$1.00	$92,400
WWT Nutrients	495 pounds/hr	$0.11	$457,380
WWT Chemicals	2 pounds/hr	$2.50	$34,230
NAOH	110 pounds/hr	$0.17	$152,460
H3PO4	22 pounds/hr	$0.37	$68,376
H2O2	44 pounds/hr	$0.50	$182,952
Cellobiase	750 pounds/yr	$150.00	$112,500 *
Cellulase	750 pounds/yr	$150.00	$112,500 *
Landfill	3,735 pounds/hr	$0.01	$313,740
TOTAL COSTS			$47,232,067

ANNUAL OPERATING REVENUES			
Alcohol	60,000,000 gal/yr	$1.35 per gal	$81,000,000
Electrical	12,932 kw/hr	$0.035 /kwh	$3,802,008
TOTAL REVENUES			$84,802,008
CASH FLOW			$37,569,941

* These are estimates of feed stock replunishment costs.
Note 1: Hay sells for $100/ton as documented in New York Agricultural Statistics, 1997-1998.

Niagara Mohawk

New York
State and Local Tax Incentives
for Manufacturers

A Brief Description

New York State does not tax **Inventory and Tangible Personal Property** (Machinery & Equipment). The **NYS Corporate Franchise Tax** is being reduced from 9% to 7.5% beginning July, 1999. Manufacturers are eligible to receive a 5% **Investment Tax Credit**, based on their investments in real estate and production machinery, which would greatly reduce this tax payable. To make Upstate New York even more attractive to manufacturers, the **Alternative Minimum Tax** is being reduced from 3.5% to 3% beginning July, 1999. Depending on the amount of the manufacturer's investment and the community where the investment is made (reference Economic Development Zone section), the **Investment Tax Credits** could reduce the manufacturer's obligation to the **alternative minimum rate**.

NYS Sales Tax is 4% on retail sale of tangible personal property. Many local governments add 3% for a total of 7%. **Machinery, equipment, tools, parts and suppleis for manufacturing are exempt from this tax**. Building materials for cosntructing a manufacturing or distribution facility can be exempted via an Industrial Development Agency (IDA).

Tax Exempt Financing for capital costs associated with production property and equipment is also available from Industrial Development Agencies (IDAs).

Property Taxes are levied by local governments to fund services and schools. Industrial Development agencies can exempt manufacturers building new facilities from property taxes for periods of 10-20 years. A Payment in Lieu of Tax **(PILOT)** agreement is arranged which results in payments to support local government and schools during the period. These payments are usually significantly less for the manufacturer than the property tax would be.

Niagara Mohawk

ECONOMIC DEVELOPMENT ZONE BENEFITS

Electric Rate Discounts
Niagara Mohawk provides the deepest discounts for business attraction and expansion in a New York State-designated Economic Development Zone. New businesses, creating new electric load are eligible to receive 10 years of deep discounts. Current Economic Development Zone Rates (EDZR) provide discounts ranging from 50-70% off standard tariff rates.
Basic Eligibility Criteria ---*Open to all non-residential customers* ---*Customer must receive and maintain local and state EDZ certification* ---*Discounts apply only to "incremental" (new to Niagara Mohawk) electricity* ---*Customer must be current in their payments to Niagara Mohawk* ---*Customer must become certified and approach Niagara Mohawk within 6 months expanding or locating in an Economic Development Zone*
Existing customers of Niagara Mohawk must increase their usage in order to receive discounts: ---*Electric demand customers must increase their demand by the lessor of 100kW or 25 percent of existing demand* ---*Electric non-demand customers must increase their usage (kWh) by at least 25 percent*
A business is not eligible for discounts, if: ---*It is a "New businesses" created by simple change in ownership* ---*You are a customer moving into an EDZ from elsewhere in Niagara Mohawk's service territory* ---*You have non-permanent increases in electric consumption (e.g. construction service, increased seasonal heating/cooling usage)*
NOTE: Discounts on gas and telephone rates are also available in Economic Development Zones.

Other Economic Development Zone Benefits	
Investment Tax Credits (ITC) Available to manufacturers investing in production property and/or equipment, industrial waste treatment facilities, air pollution control facilities or research and development property. ***---10% ITC for corporations*** ***---8% ITC for individuals***	**Employment Incentive Credit (EIC)** Available to businesses who have received the EDZ ITC and have increased employment (must be 101% of the average number of employees in the year before the ITC was claimed). ***---30% of the EDZ ITC for up to 3 consecutive years***
Wage Tax Credit (WTC) Available to businesses which hire new employees. Credit is for a 5-year term, beginning with the first tax year in which EDZ wages are paid. ***---$1,500 for *targeted employees paid at least 135% of minimum wage*** ***---$750 for all other employees***	**WTC and ITC Refunds** Generally available to new businesses less than four years old or new to New York state and eligible for WTC and/or ITC. ***---50% Cash Refund or Eligible WTC and/or ITC***
NOTE: Targeted employees are individuals hired from public assistance rolls, dislocated workers and other disadvantaged individuals.	

G. PLANT LABOR ESTIMATE

The plant crewing was assembled on the basis of other projects and special needs for this proposed plant. Of special note are the Logistic Supervisors. Based on previous experience and recent literature, these people will be in the interface with the farmers for securing the biomass. There are four (4) of them to take on quadrants of the surrounding area. They will need to locate the suppliers, possibly negotiate the contracts, and establish the supply schedule for the materials. Continuous follow-up will be required to ensure smooth feedstock supply to the plant.

The crewing is based on seven (7) day rotating shifts with two (2) days off between shifts. Other combinations are possible. Additional maintenance crewing may be needed from time to time for specialty repairs or outages. The crane operators only work two shifts. Shift supervisors manage their own maintenance crew with oversight of the maintenance supervisor. Either the operations managers or some other manager assumes duties of assistant plant manager

ESTIMATED PLANT LABOR COST
WITH ENZYME PRODUCTION

Staffing	No. of People	Rate (W2)	Salary	Cost w/benefits 1.23
Plant Manager	1	$ 62.50	$125,000	$153,750
Secretary	1	$ 20.00	$40,000	$49,200
Human Resources Manager	1	$ 40.00	$80,000	$98,400
Clerk	1	$ 25.00	$50,000	$61,500
Accounting Manager	1	$ 45.00	$90,000	$110,700
Clerk	1	$ 15.00	$30,000	$36,900
Check Writer	1	$ 20.00	$40,000	$49,200
Senior Plant Engineer	1	$ 40.00	$80,000	$98,400
Plant Engineer	1	$ 35.00	$70,000	$86,100
QC Manager	1	$ 45.00	$90,000	$110,700
Senior Chemist	1	$ 35.00	$70,000	$86,100
Chemists	4	$ 25.00	$200,000	$246,000
Utility	4	$ 15.00	$120,000	$147,600
Procurement Manager	1	$ 35.00	$70,000	$86,100
Logistics Manager	1	$ 55.00	$110,000	$135,300
Supervisors	4	$ 35.00	$280,000	$344,400
Clerks	2	$ 15.00	$60,000	$73,800
Shipping & Receiving Manager	1	$ 35.00	$70,000	$86,100
Guards	8	$ 20.00	$320,000	$393,600
Shipping & Receiving Utility	2	$ 20.00	$80,000	$98,400
Operations Manager	1	$ 55.00	$110,000	$135,300
Shift Supervisors	4	$ 30.00	$240,000	$295,200
Control Room Operators	8	$ 25.00	$400,000	$492,000
Licensed Boiler Operators	4	$ 30.00	$240,000	$295,200
Utilities	4	$ 15.00	$120,000	$147,600
Crane Operators	16	$ 20.00	$640,000	$787,200
WWT operators	4	$ 20.00	$160,000	$196,800
Maintenance Supervisor	1	$ 45.00	$90,000	$110,700
Mechanical	4	$ 30.00	$240,000	$295,200
Welders	4	$ 30.00	$240,000	$295,200
Electrical	4	$ 30.00	$240,000	$295,200
Utilities	4	$ 20.00	$160,000	$196,800
Enzyme Operators	4	$ 25.00	$200,000	$246,000
Samplers	2	$ 20.00	$80,000	$98,400
Weighers	2	$ 20.00	$80,000	$98,400
Totals	104	$ 25.55	$5,315,000	$6,537,450

Project 78849.001
NYSTEC

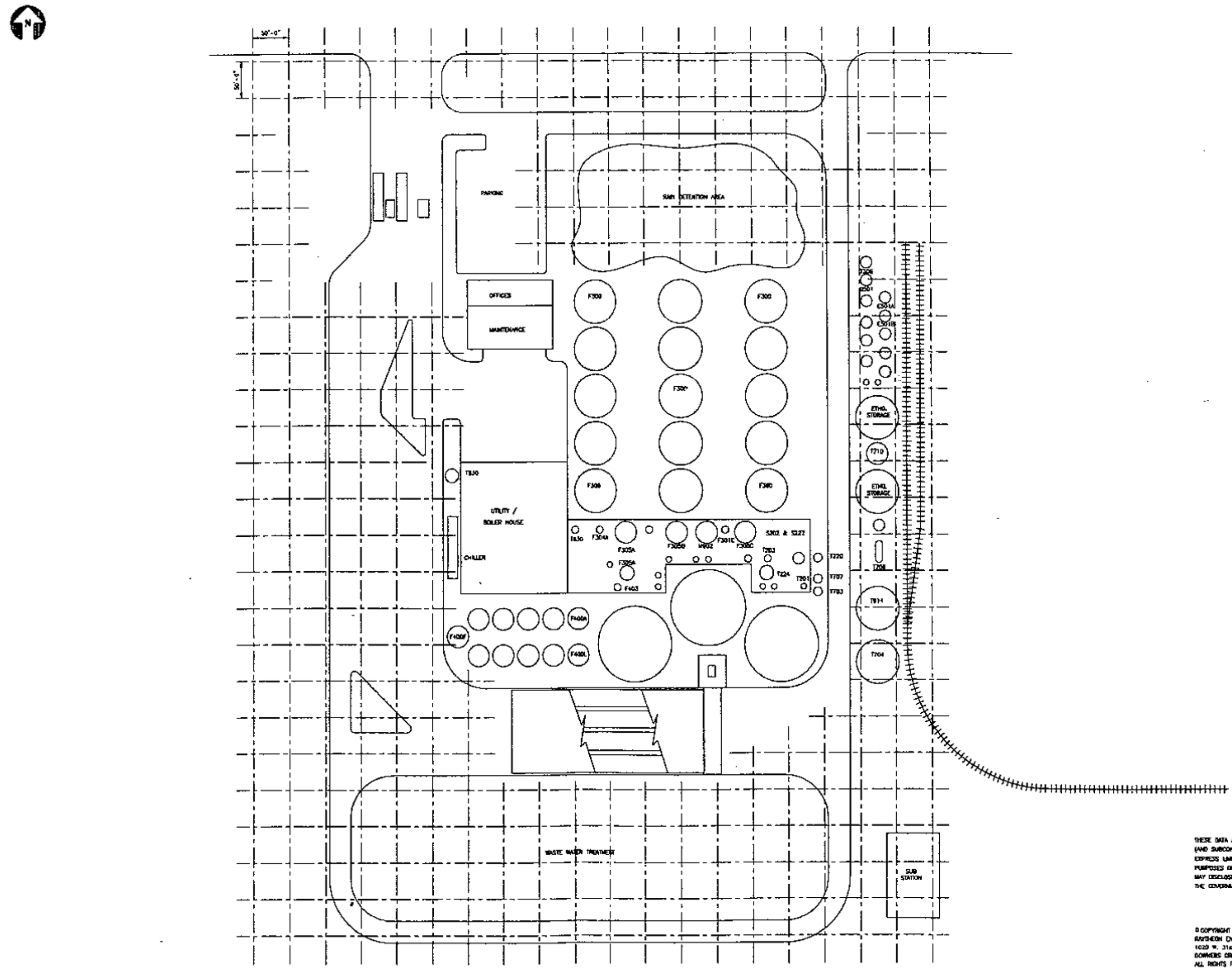
ESTIMATED PLANT LABOR COST WITHOUT ENZYME PRODUCTION

Rev. A, 7/22/99

Staffing	No. of People	Rate (W2)	Salary	Cost w/benefits 1.23
Plant Manager	1	$ 62.50	$125,000	$153,750
Secretary	1	$ 20.00	$40,000	$49,200
Human Resources Manager	1	$ 40.00	$80,000	$98,400
Clerk	1	$ 25.00	$50,000	$61,500
Accounting Manager	1	$ 45.00	$90,000	$110,700
Clerk	1	$ 15.00	$30,000	$36,900
Check Writer	1	$ 20.00	$40,000	$49,200
Senior Plant Engineer	1	$ 40.00	$80,000	$98,400
Plant Engineer	1	$ 35.00	$70,000	$86,100
QC Manager	1	$ 45.00	$90,000	$110,700
Senior Chemist	1	$ 35.00	$70,000	$86,100
Chemists	4	$ 25.00	$200,000	$246,000
Utility	4	$ 15.00	$120,000	$147,600
Procurement Manager	1	$ 35.00	$70,000	$86,100
Logistics Manager	1	$ 55.00	$110,000	$135,300
Supervisors	4	$ 35.00	$280,000	$344,400
Clerks	2	$ 15.00	$60,000	$73,800
Shipping & Receiving Manager	1	$ 35.00	$70,000	$86,100
Guards	8	$ 20.00	$320,000	$393,600
Shipping & Receiving Utility	2	$ 20.00	$80,000	$98,400
Operations Manager	1	$ 55.00	$110,000	$135,300
Shift Supervisors	4	$ 30.00	$240,000	$295,200
Control Room Operators	8	$ 25.00	$400,000	$492,000
Licensed Boiler Operators	4	$ 30.00	$240,000	$295,200
Utilities	4	$ 15.00	$120,000	$147,600
Crane Operators	16	$ 20.00	$640,000	$787,200
WWT operators	4	$ 20.00	$160,000	$196,800
Maintenance Supervisor	1	$ 45.00	$90,000	$110,700
Mechanical	4	$ 30.00	$240,000	$295,200
Welders	4	$ 30.00	$240,000	$295,200
Electrical	4	$ 30.00	$240,000	$295,200
Utilities	4	$ 20.00	$160,000	$196,800
Totals	96	$ 25.81	$4,955,000	$6,094,650

H. CONCEPTUAL PLANT LAYOUT

This is a non-site specific plant layout. The plant layout could be utilized for the Robbins Corn and Bulk Service. Even though there is a north arrow on the drawing, there are no established criteria for the orientation. No equipment specific layout has been undertaken to establish the size of the buildings. Building size is based on previous experience and the information available in the NREL study.



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	A	3/14/99					

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	STRUCTURAL			INST & CONTROL		
	MECH POWER			MECH SERVICES		
	ELECTRICAL			PROCESS		
	R & QA					

DATE | SENT | NO. PTS.
PRINT RECORD

SCALE: 1" = 50'-0"

Raytheon Engineers & Constructors

NYSTEC

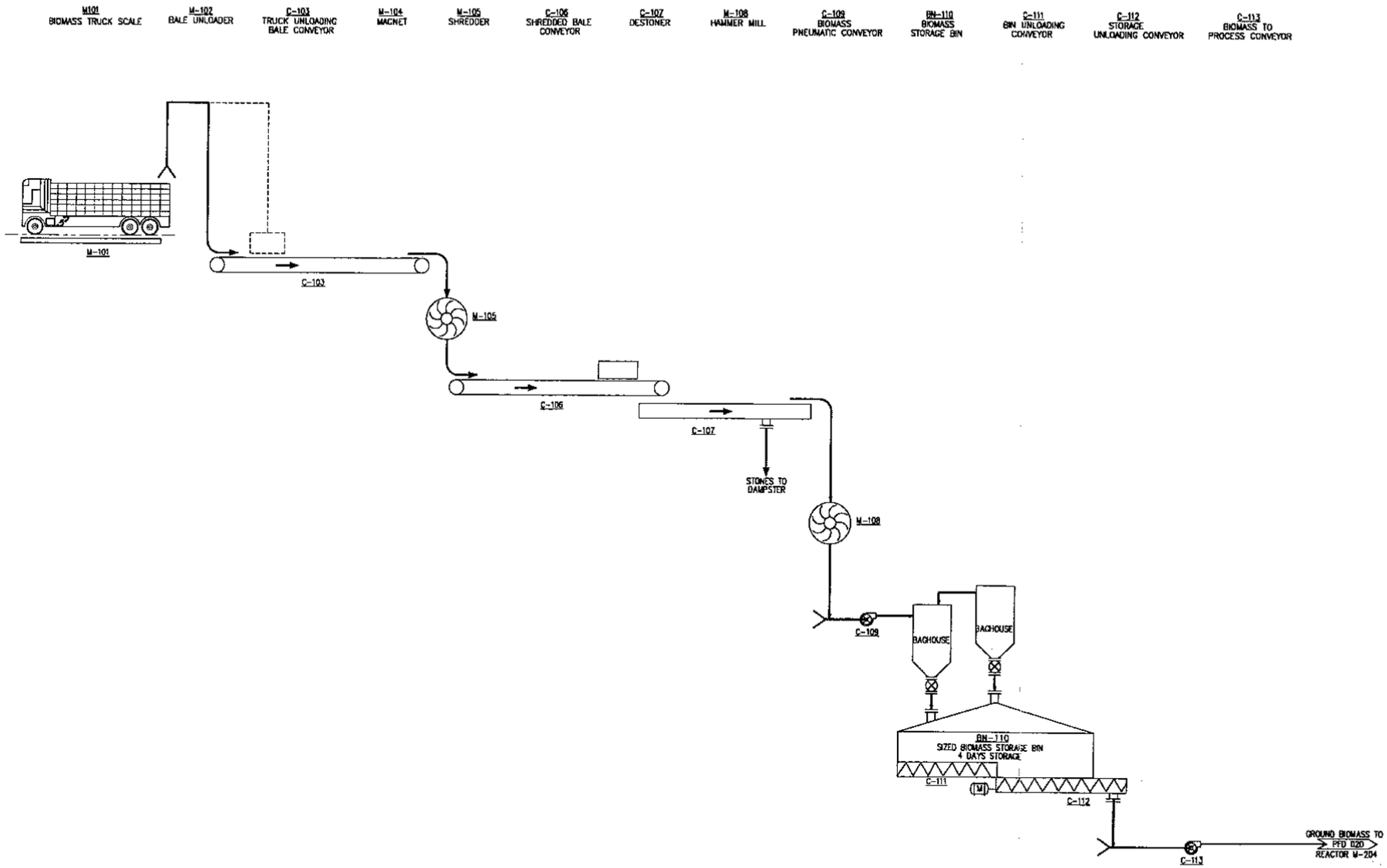
SITE LAYOUT STUDY
BIOMASS TO ETHANOL PLANT
NON-SITE SPECIFIC

DWG NO GA-01 REV NO A

I. PROCESS FLOW DIAGRAMS

These are the related process flow diagrams. Physical depictions of process equipment are not necessarily accurately represented.

PFD10 – Feed Handling
PFD20 – Prehydrolysis & Detoxification
PFD21 – Lime Addition
PFD30 – SSCF Seed Fermentation
PFD31 – SSCF Production Fermentation
PFD40 – Cellulase Seed Fermentation
PFD41 – Cellulase Production Fermentation
PFD50 – Beer & Rectification Distillation
PFD51 – Evaporation & Ethanol Dehydration
PFD60 – Lignin Separation and Recycle
PFD61 – Anaerobic & Aerobic Digestion
PFD70 – Liquid Storage
PFD80 – Combustor and Turbo Generator
PFD81 – Boiler Feed Water Preparation & Chemicals
PFD90 – Cooling Water, Chilled Water, Process Water, CIP System
PFD91 – CIP System
PFD92 – Plant/Instrument Air & Fermentation Air



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	RE&C APP'D	CLIENT APP'D
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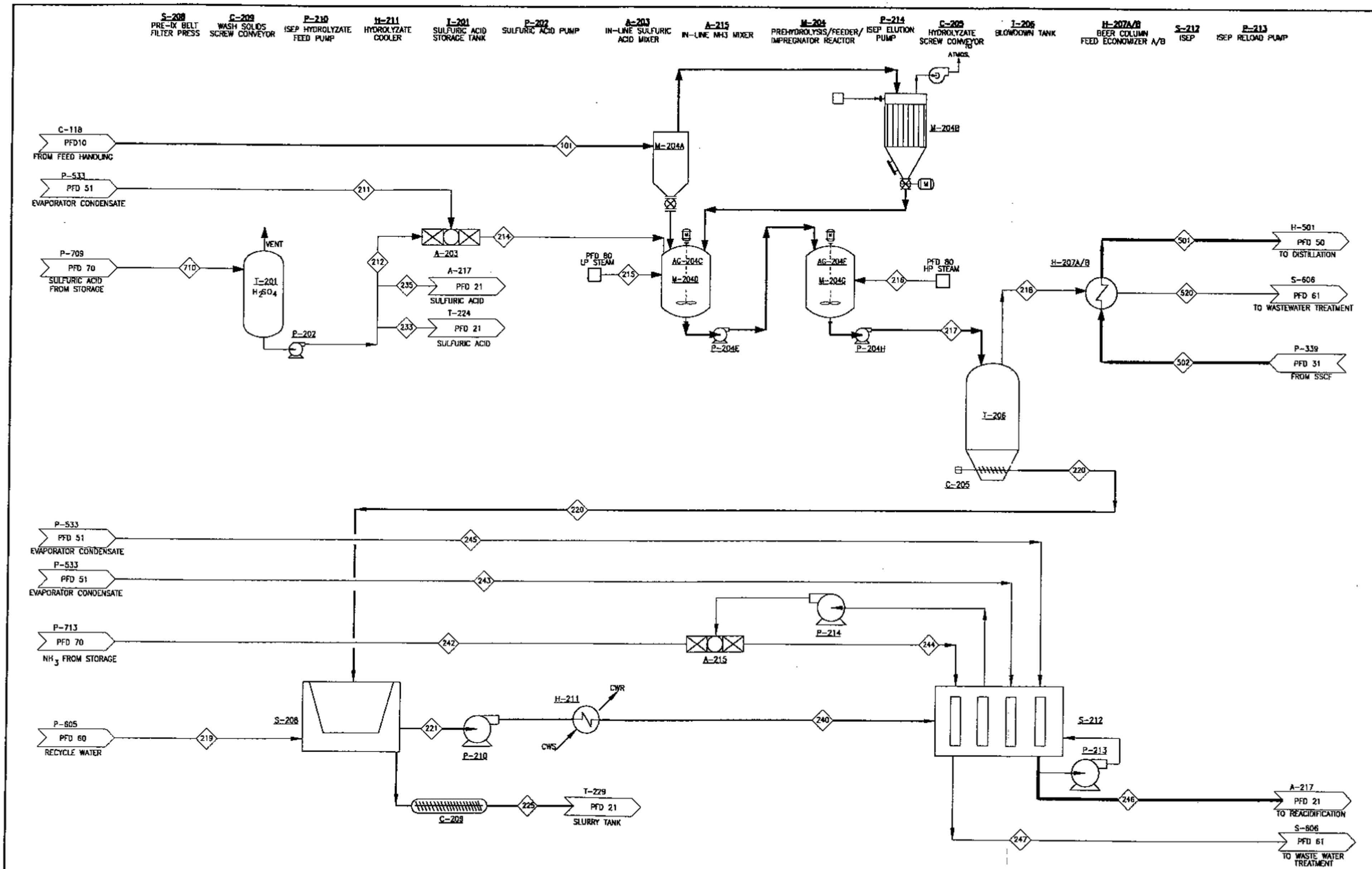
DRAWN RBP	DATE 05/10/99	NYSTEC	PROJECT NUMBER 78849.001
CHECKED	DATE	TITLE: PROCESS FLOW DIAGRAM	DRAWING NUMBER PFD10
RE&C APPROVED	DATE	FEED HANDLING	REVISION A
CLIENT APPROVED	DATE		SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
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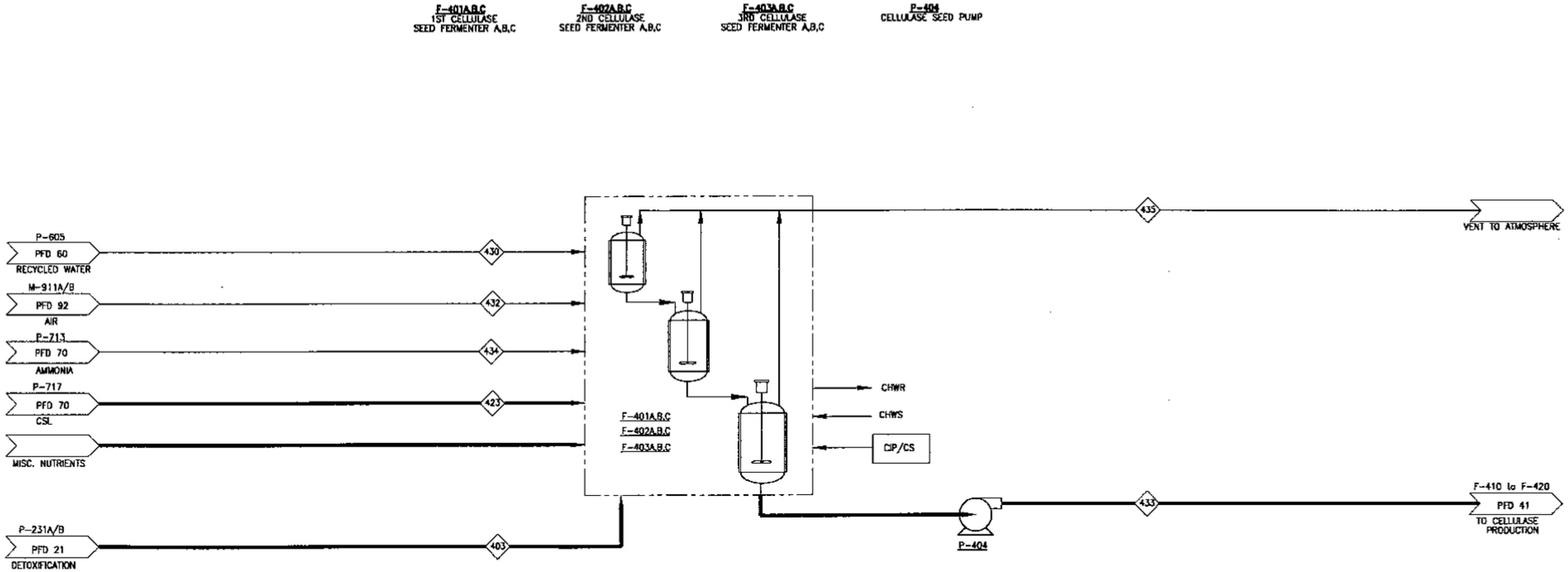
DRAWN RBP	DATE 05/06/99		PROJECT NUMBER 78849.001
CHECKED	DATE	NYSTEC	DRAWING NUMBER PFD20
REAC APPROVED	DATE	TITLE: PROCESS FLOW DIAGRAM PREHYDROLYSIS & DETOXIFICATION	REVISION A
CLIENT APPROVED	DATE		SCALE: NONE

CAD FILE NAME



UTILITY LEGEND	
1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	RE&C APP'D	CLIENT APP'D
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DRAWN	DATE
RBP	05/11/99
CHECKED	DATE
RE&C APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
CELLULASE SEED FERMENTATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD40
REVISION A
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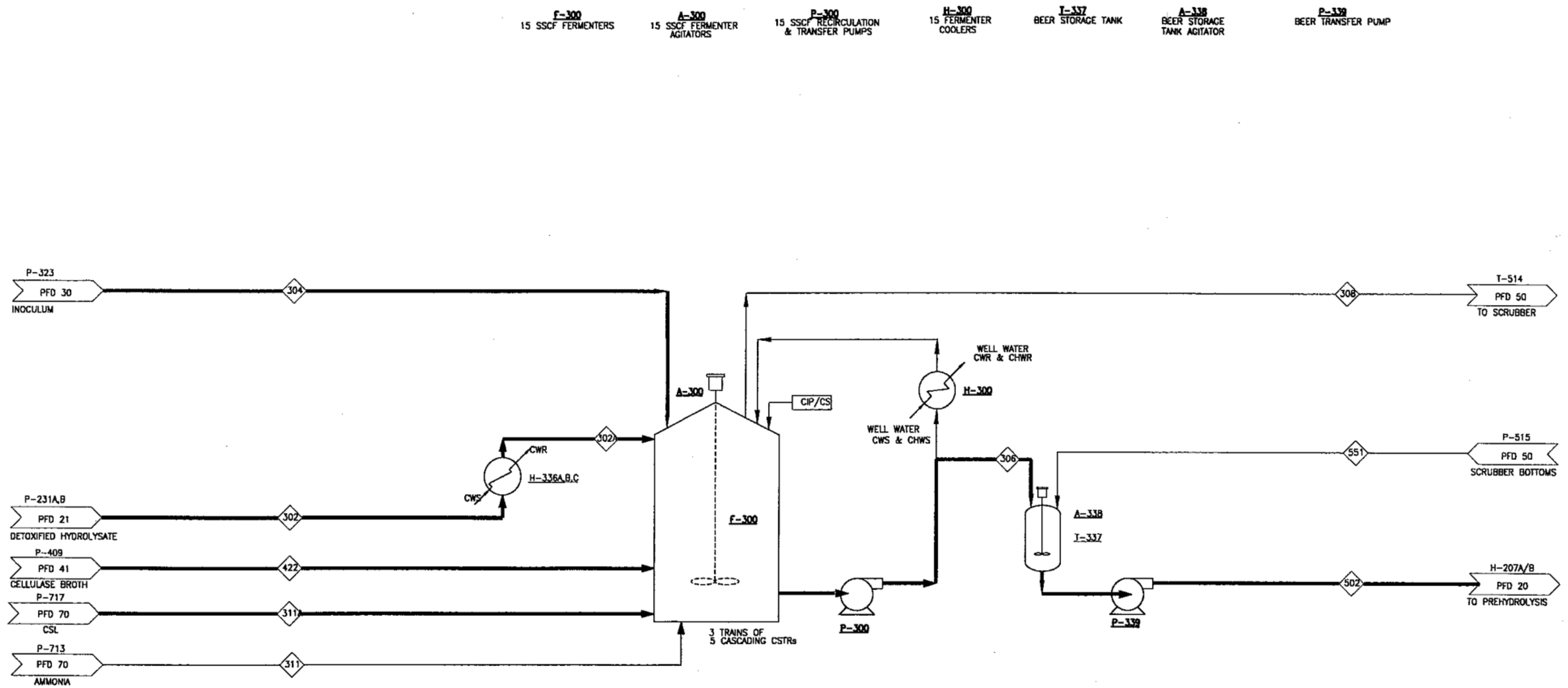

UTILITY LEGEND

[1] HP STEAM
[2] LP STEAM
[3] HP CONDENSATE
[4] LP CONDENSATE
[5] CITY WATER (POTABLE)
[6] PROCESS WATER
[7] COOLING TOWER WATER SUPPLY
[8] COOLING TOWER WATER RETURN
[9] HOT WATER SUPPLY
[10] HOT WATER RETURN
[11] CIP SUPPLY
[12] CIP RETURN
[13] PLANT AIR
[14] STERILE AIR
[15] WASTE
[16] VENT
[17] NATURAL GAS

REV. NO.	DATE	REVISION	BY	RE&C APP'D	CLIENT APP'D
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DOWNERS GROVE, ILLINOIS

DRAWN: RBP	DATE: 05/11/99
CHECKED	DATE
RE&C APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
SSCF PRODUCTION FERMENTATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD31
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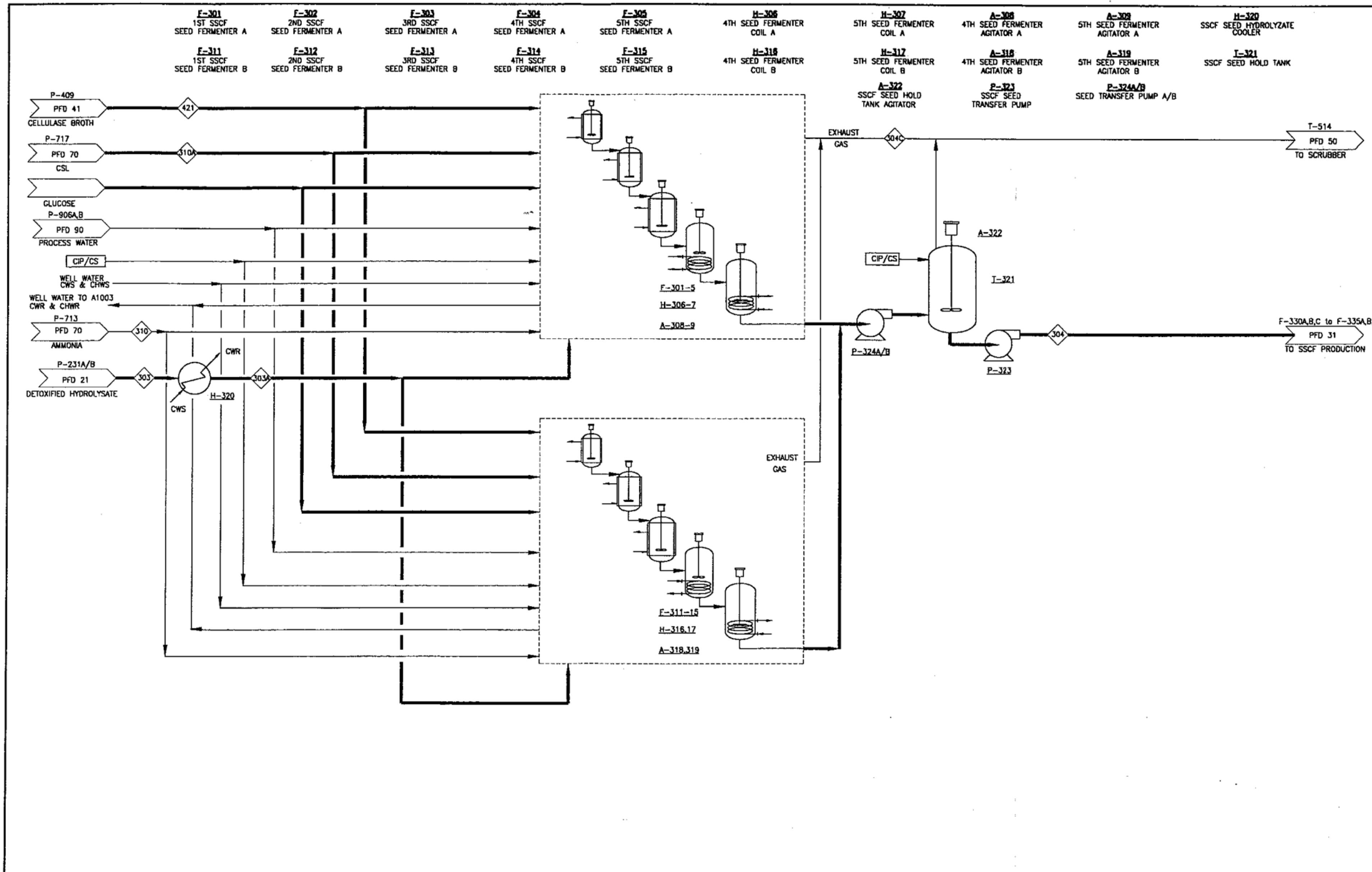

UTILITY LEGEND	
[1] HP STEAM	[10] HOT WATER RETURN
[2] LP STEAM	[11] CIP SUPPLY
[3] HP CONDENSATE	[12] CIP RETURN
[4] LP CONDENSATE	[13] PLANT AIR
[5] CITY WATER (POTABLE)	[14] STERILE AIR
[6] PROCESS WATER	[15] WASTE
[7] COOLING TOWER WATER SUPPLY	[16] VENT
[8] COOLING TOWER WATER RETURN	[17] NATURAL GAS
[9] HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	RE&C APP'D	CLIENT APP'D
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Raytheon Engineers & Constructors
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DRAWN: RBP	DATE: 05/11/99	NYSTEC	PROJECT NUMBER: 78849.001
CHECKED	DATE		DRAWING NUMBER: PFD30
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CLIENT APPROVED	DATE	SSCF SEED FERMENTATION	SCALE: NONE

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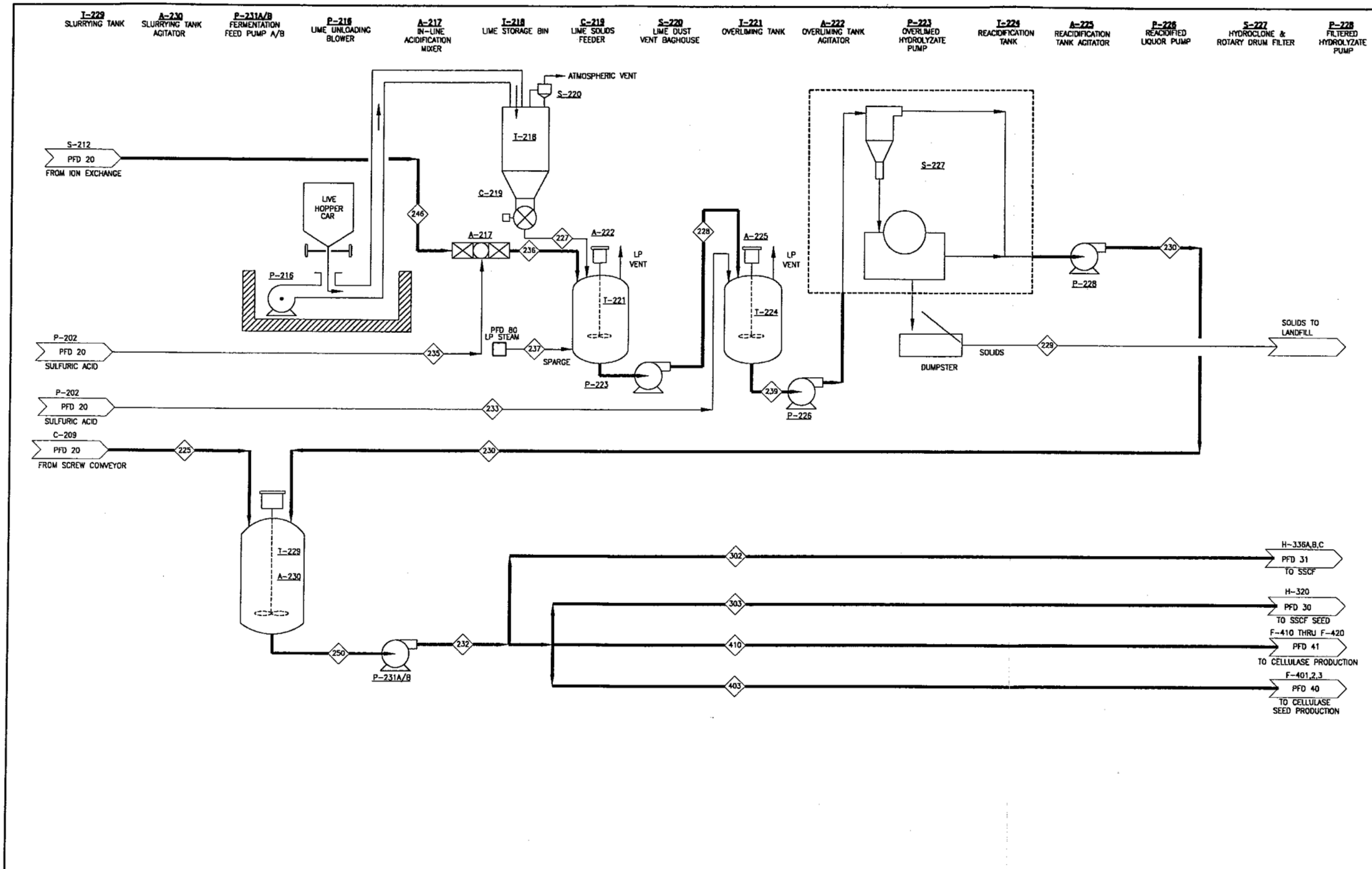


UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CIP SUPPLY
12 CIP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

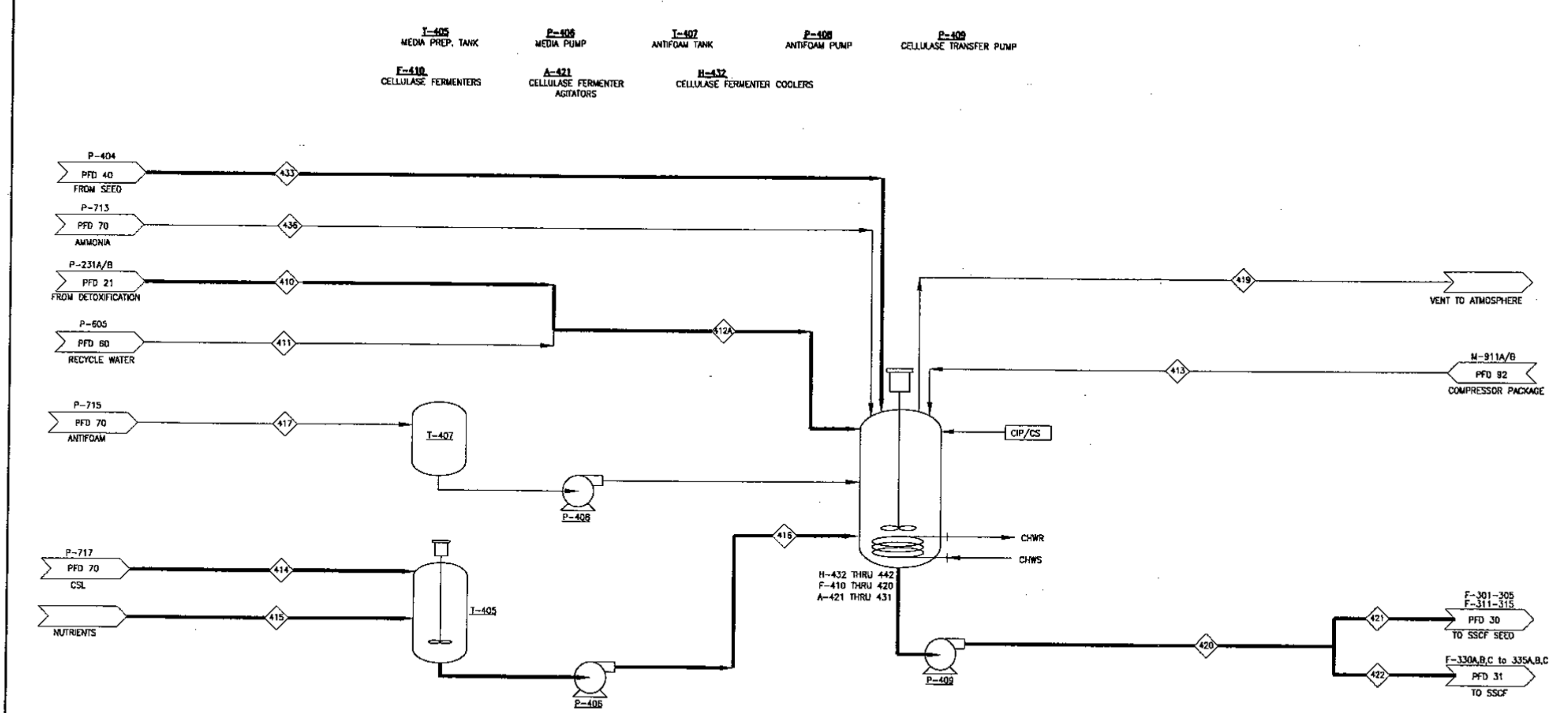
Raytheon Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DRAWN / DATE
CHECKED / DATE
RE&C APPROVED / DATE
CLIENT APPROVED / DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
LIME ADDITION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD21
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CIP SUPPLY
12 CIP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
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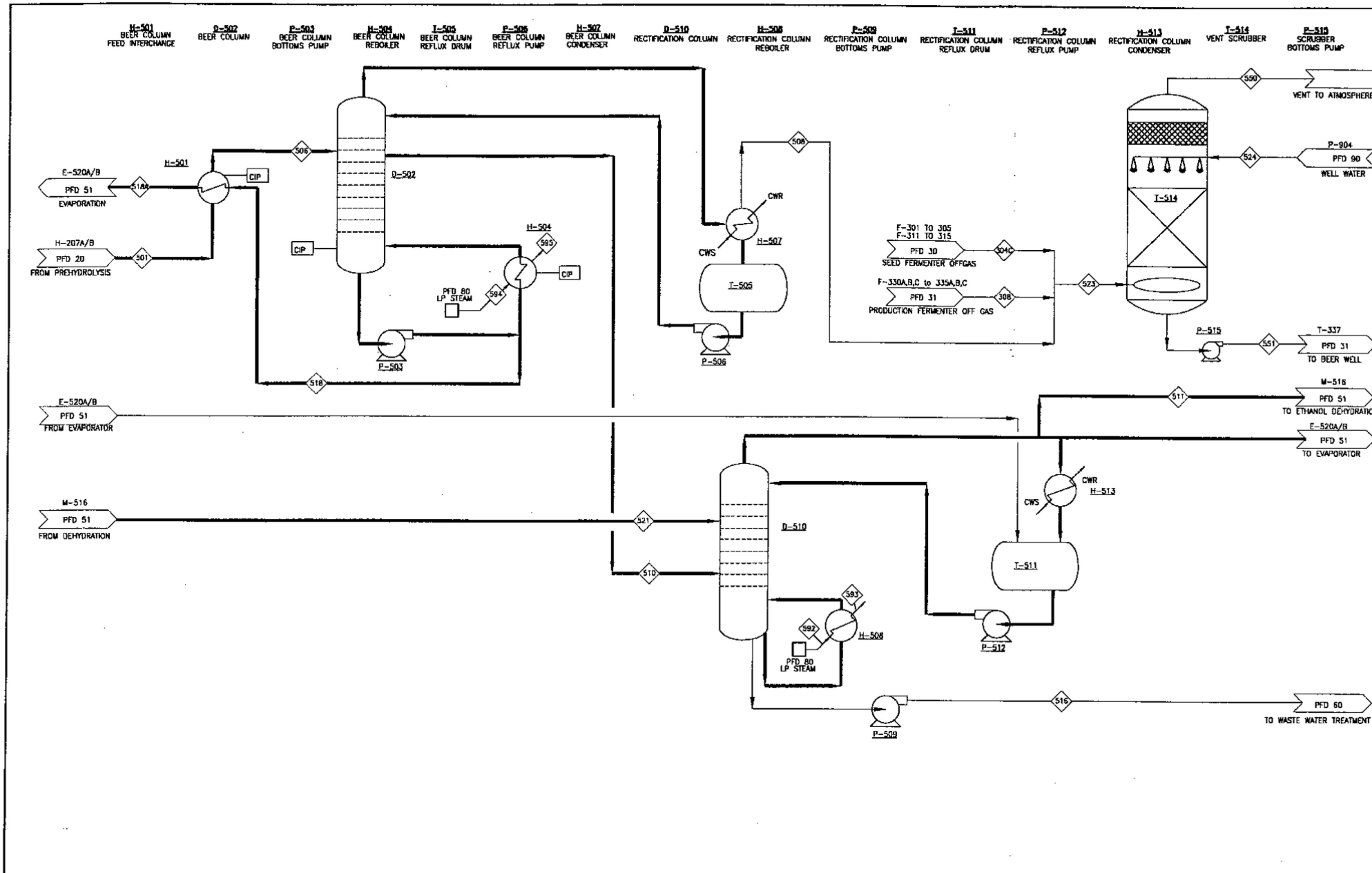
Raytheon Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DRAWN: RBP DATE: 05/11/99
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
CELLULASE PRODUCTION FERMENTATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD41
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CIP SUPPLY
12 CIP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

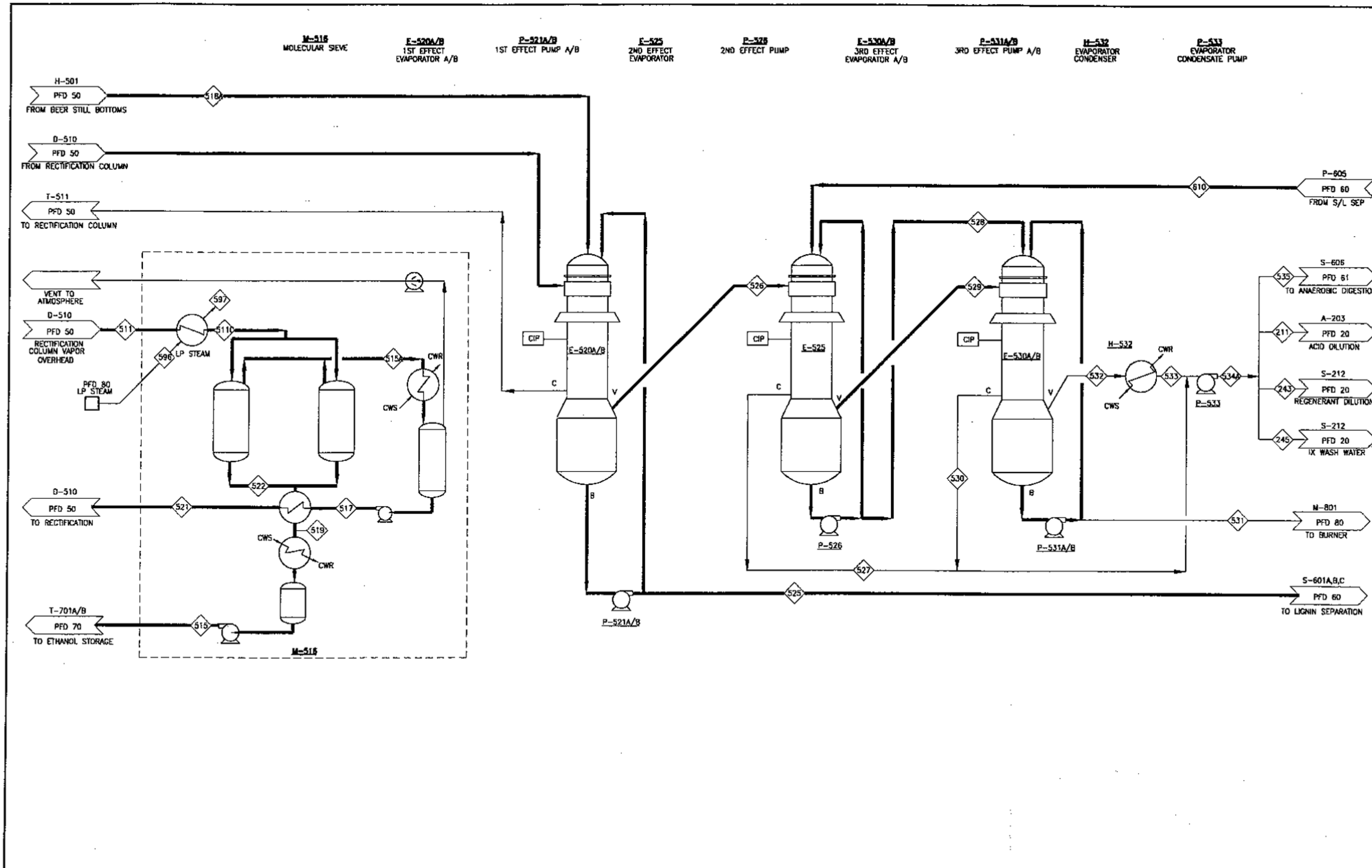
Raytheon Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DRAWN: RBP DATE: 06/06/99
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
BEER & RECTIFICATION DISTILLATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD50
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

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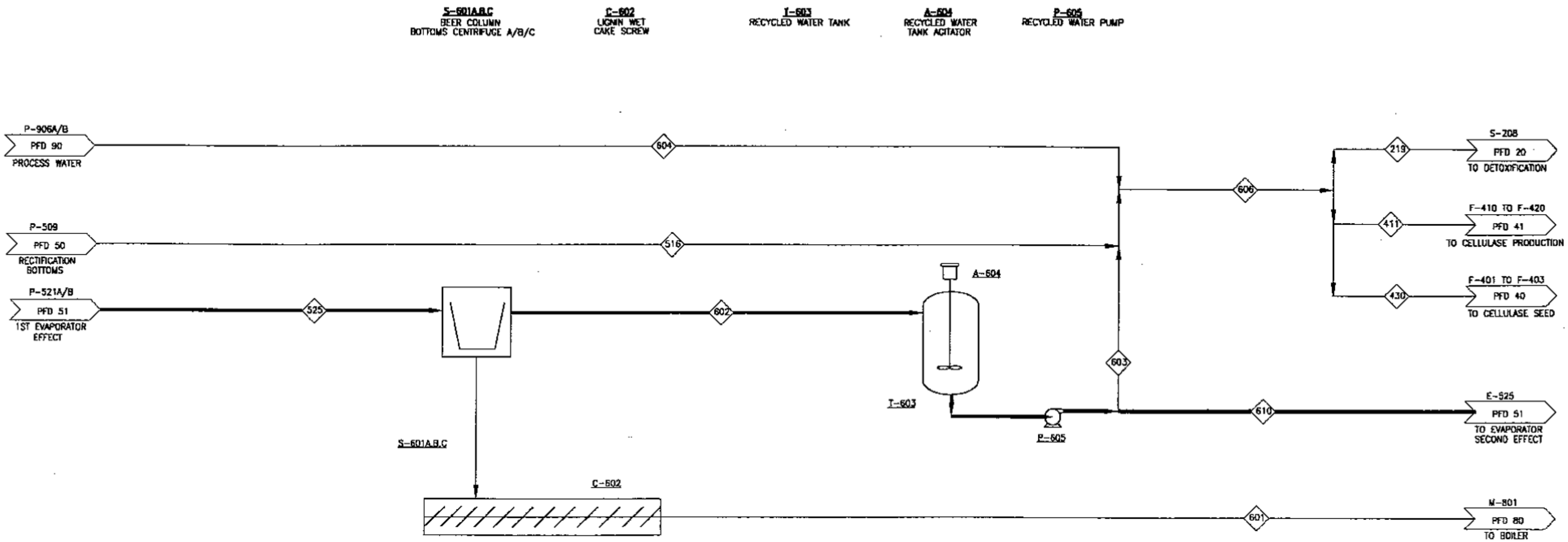
DOWNERS GROVE, ILLINOIS

DRAWN RBP	DATE 05/06/99
CHECKED	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
EVAPORATION & ETHANOL DEHYDRATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD51
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

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DRAWN	DATE
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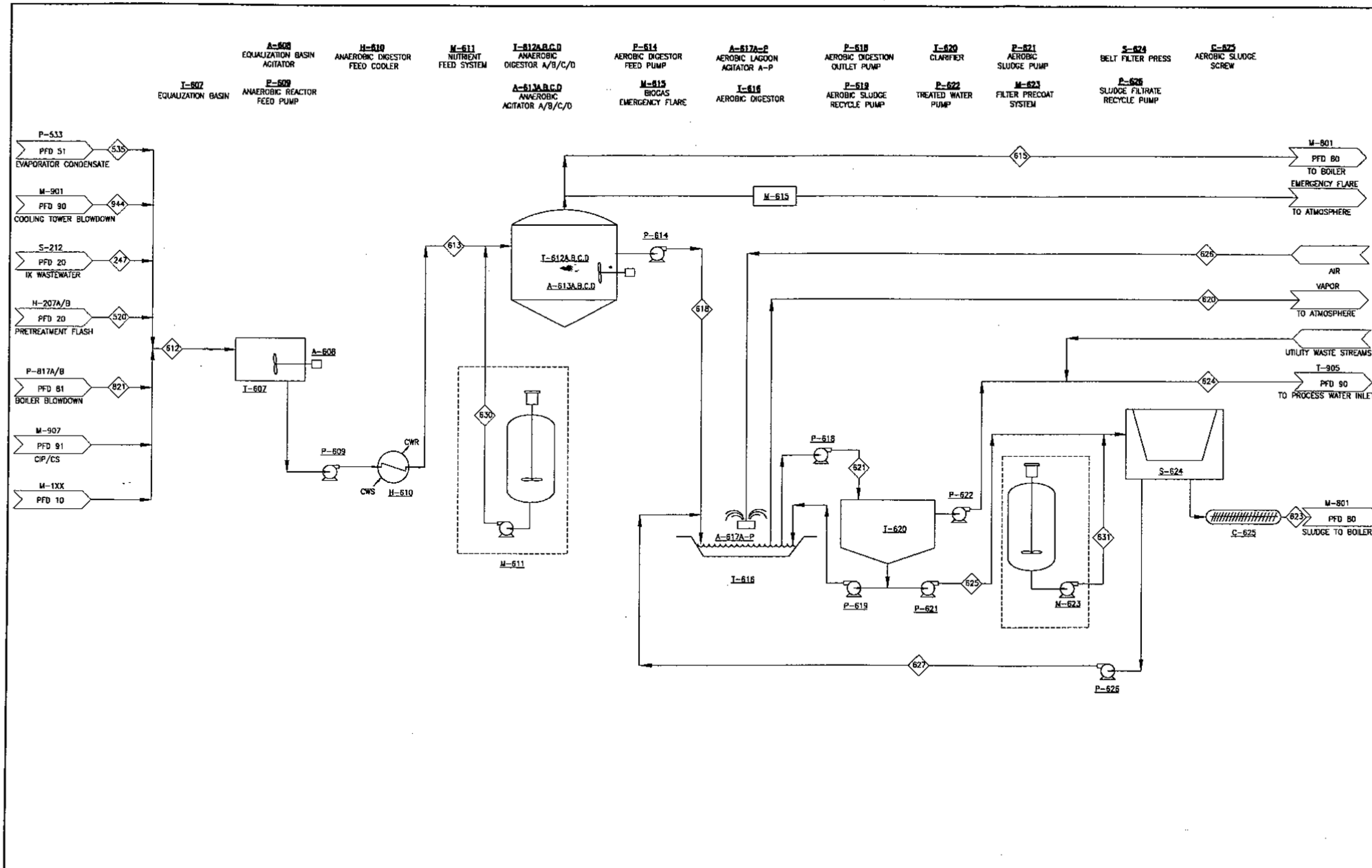
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
LIGNIN SEPARATION AND RECYCLE

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD60
REVISION A
SCALE: NONE



UTILITY LEGEND	
1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	RE&C APP'D	CLIENT APP'D
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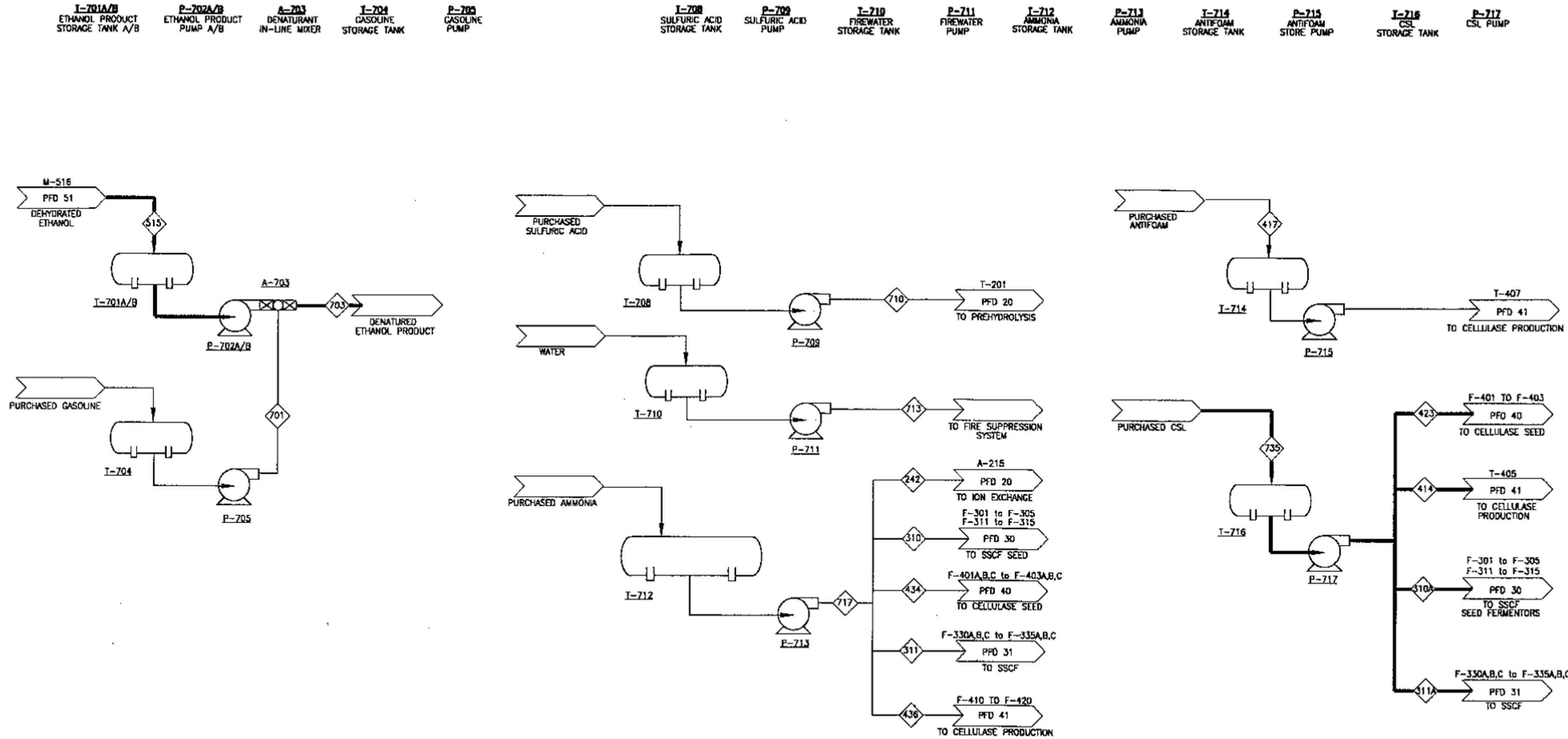
DRAWN | DATE
CHECKED | DATE
RE&C APPROVED | DATE
CLIENT APPROVED | DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
ANAEROBIC & AEROBIC DIGESTION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD61
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CIP SUPPLY
12 CIP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

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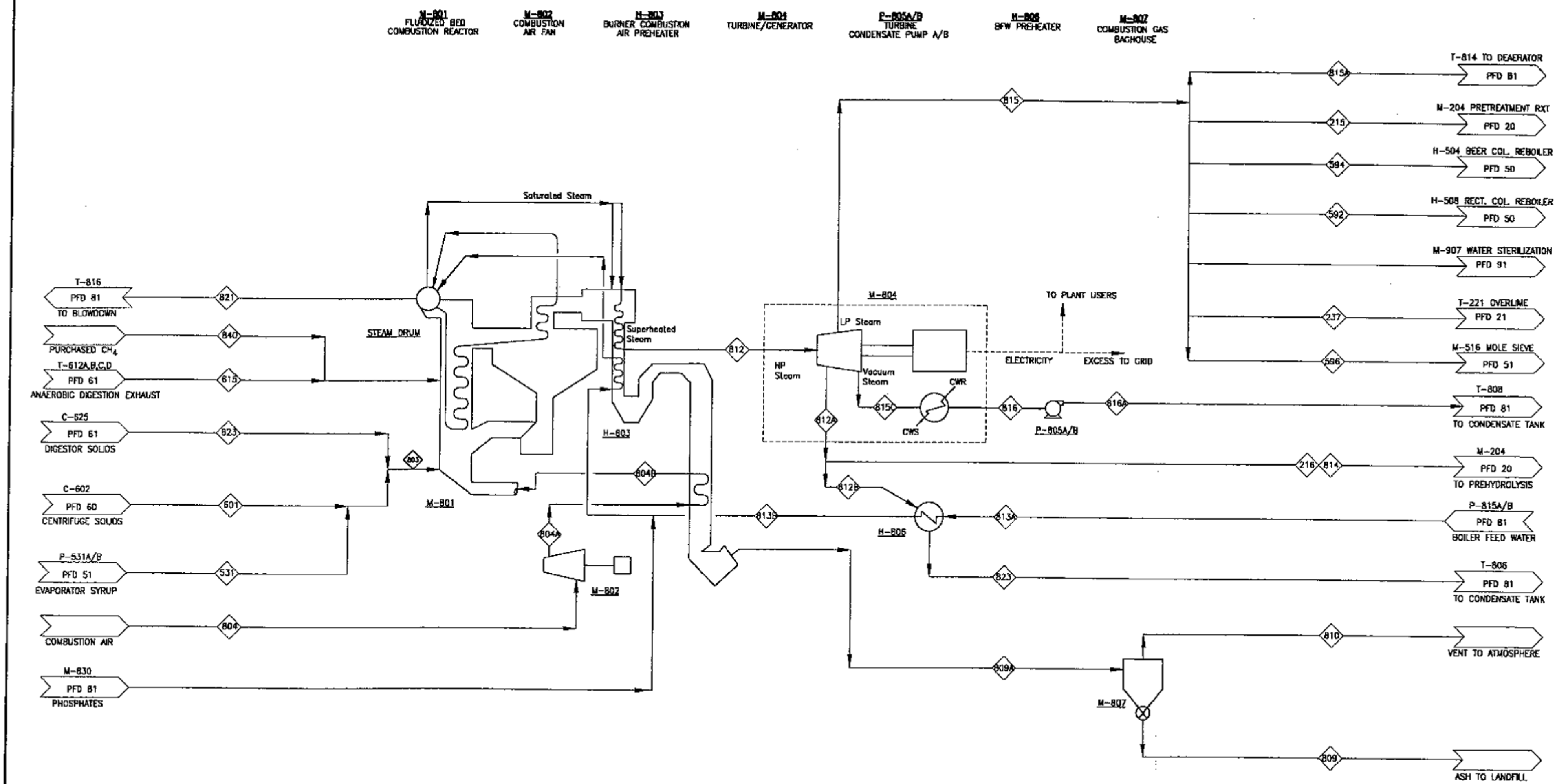
DOWNERS GROVE, ILLINOIS

DRAWN: RSP
DATE:
CHECKED:
DATE:
REAC APPROVED:
DATE:
CLIENT APPROVED:
DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
LIQUID STORAGE

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD70
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

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A					

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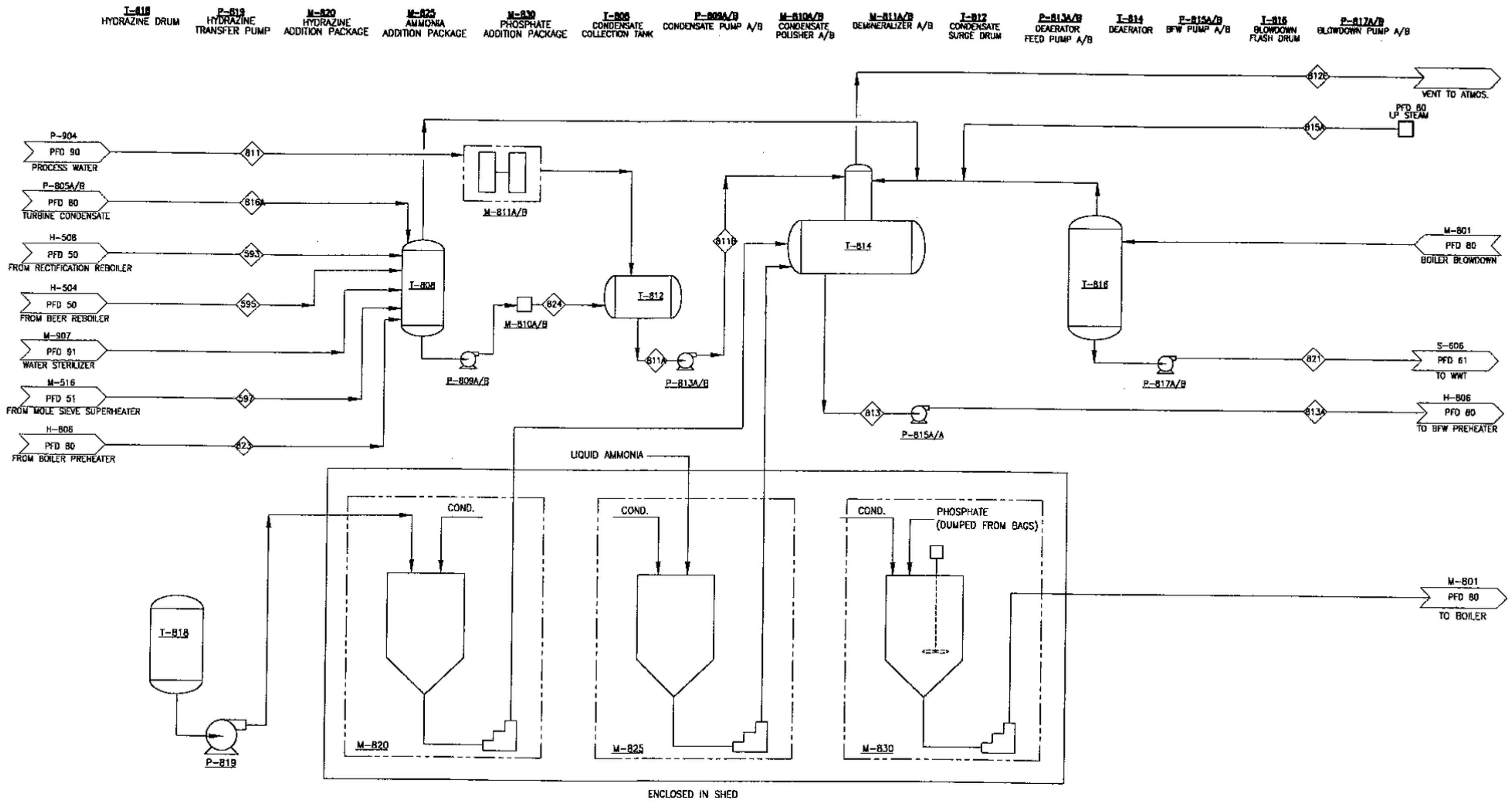
DOWNERS GROVE, ILLINOIS

DRAWN	DATE
RBP	05/08/99
CHECKED	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
COMBUSTOR AND TURBO GENERATOR

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD80
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CIP SUPPLY
12 CIP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

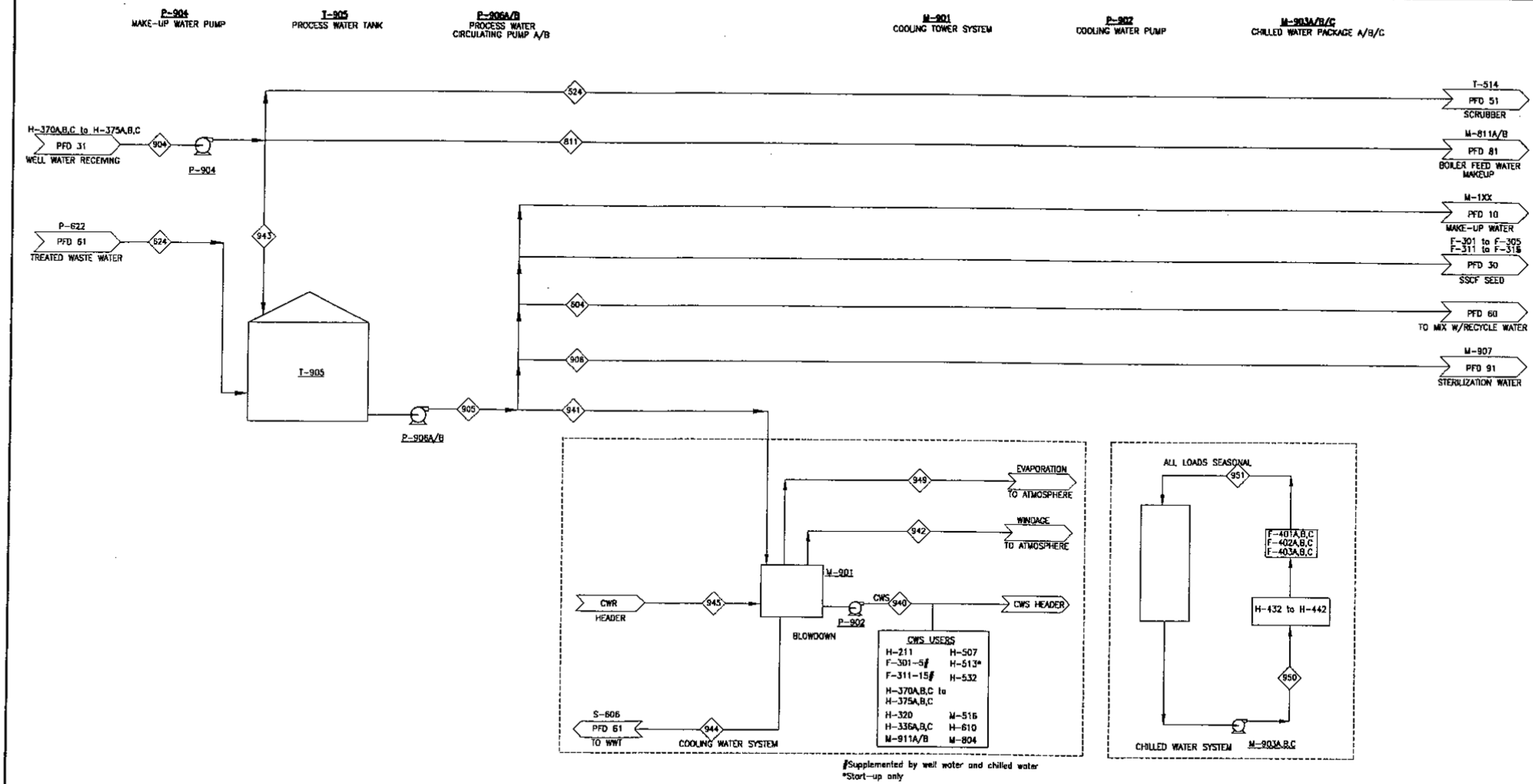
Raytheon Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DRAWN: RBP DATE: 05/08/99
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
BOILER FEED WATER
PREPARATION & CHEMICALS

PROJECT NUMBER: 78849.001
DRAWING NUMBER: PFD81
REVISION: A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CIP SUPPLY
12 CIP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
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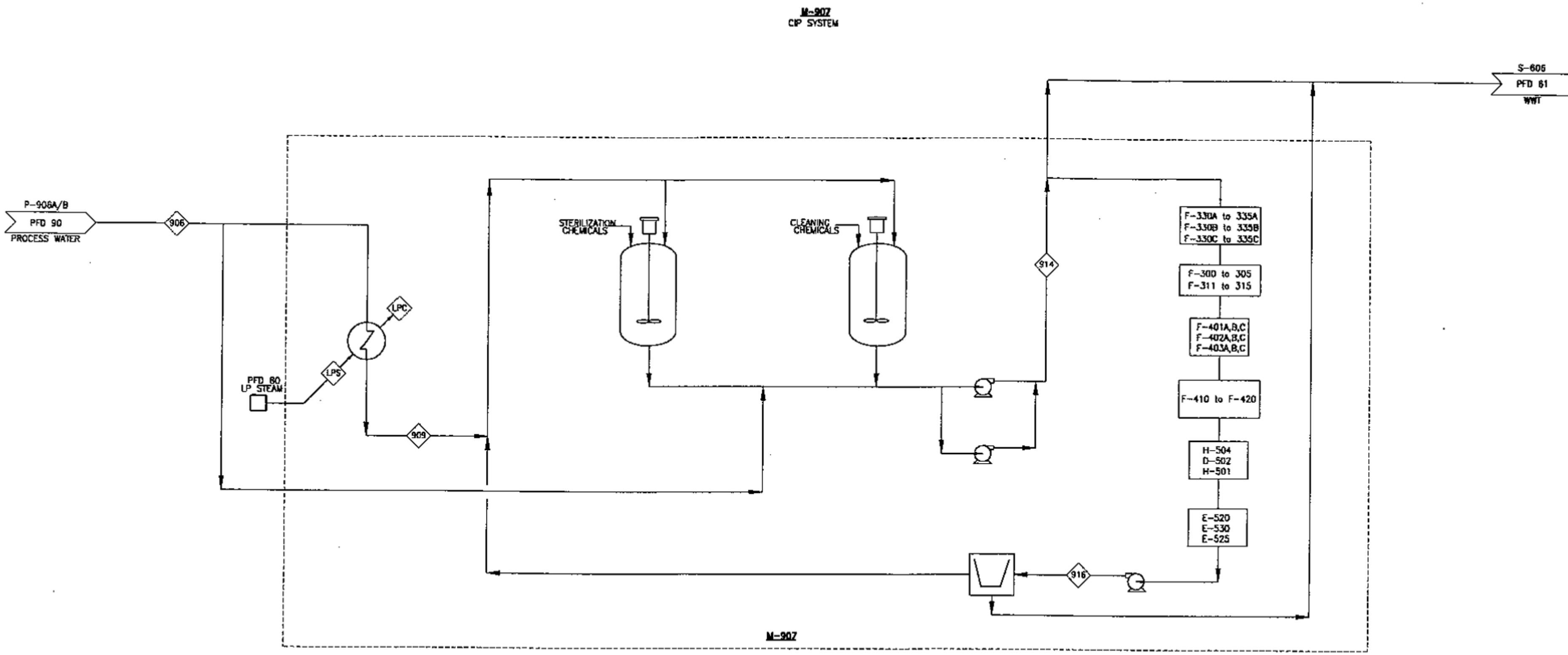
DOWNERS GROVE, ILLINOIS

DRAWN	DATE
RBP	05/10/99
CHECKED	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
COOLING WATER, CHILLED WATER,
PROCESS WATER

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD90
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A					

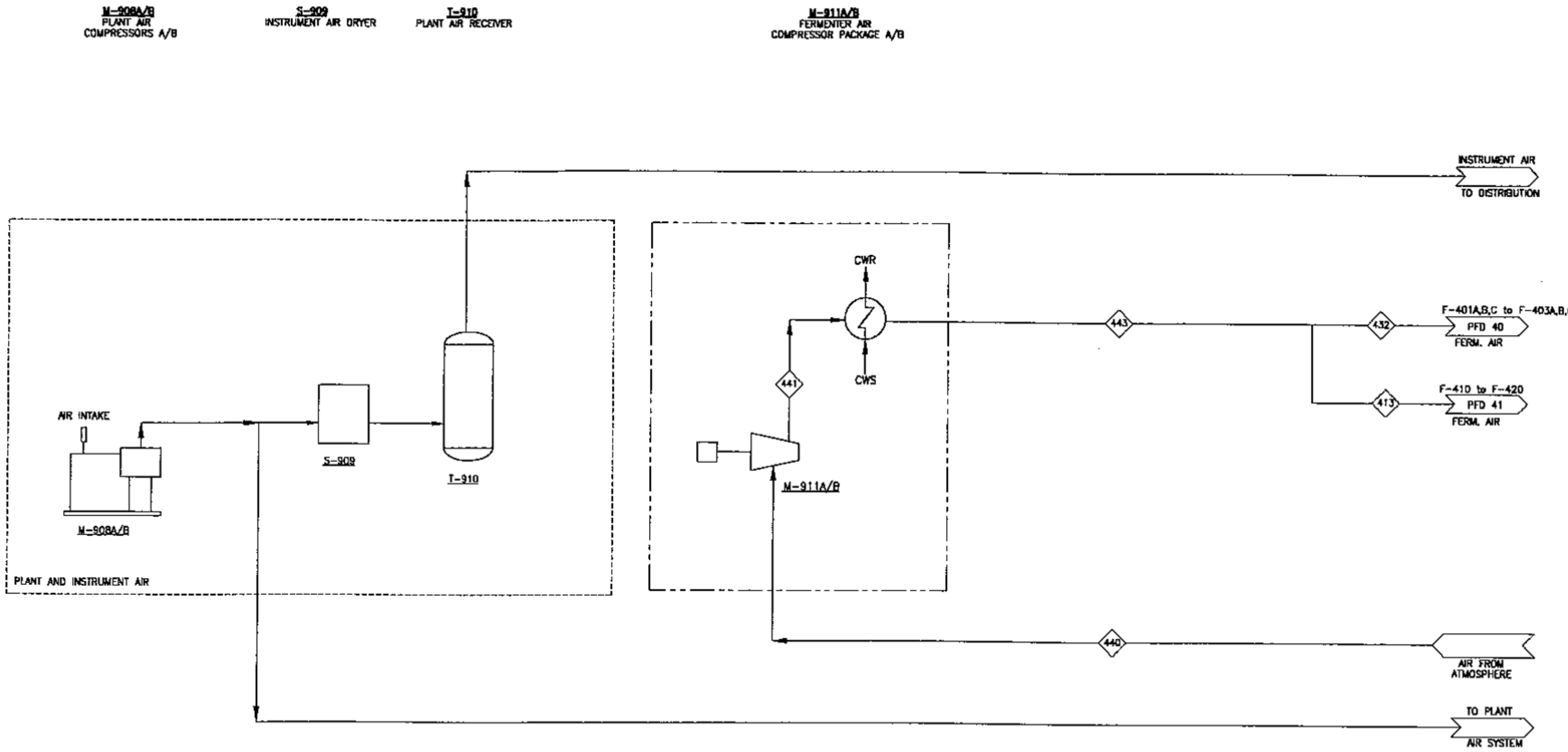
Raytheon Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DRAWN	DATE
RBP	05/10/99
CHECKED	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
CIP SYSTEM

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD91
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
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7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
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DOWNERS GROVE, ILLINOIS

DRAWN: RBP	DATE: 05/10/99
CHECKED	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
PLANT / INSTRUMENT AIR & FERMENTATION AIR

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD92
REVISION A
SCALE: NONE

III. CORN TO ETHANOL PLANT REFERENCE

A. PROCESS DESCRIPTION

This reference is a standard 30MM gal/yr corn to ethanol plant, utilizing a typical dry corn grind with wet distiller's grain by-product. Since the wet feed can be utilized for dairy cattle on an immediate basis, drying is not needed and can save capitol investment costs. The plant saccharification is accomplished through a purchased enzyme. The starch cooking is by steam jet cooker. The fermentation is done by purchased enzymes. The recovery of alcohol is a two-column distillation system with molecular sieve dehydration. There is no co-generation of power. No by-product germ or gluten streams are made.

B. PROCESS PLANT SUMMARY CONSTRUCTION COST ESTIMATE

This cost estimate was developed from a green field, site-specific Fall, 1998 project. The cost estimate is based on equipment quotes and material take-offs developed through extensive preliminary engineering efforts. The equipment take-offs are presented in the priced equipment list. The estimate includes site development costs.

Raytheon Engineers & Constructors

CLIENT: NYSTEC
PROJECT: 30 MM GAL/YR CORN TO ETHANOL FACILITY
LOCATION: NEW YORK
JOB NO.: 78849.001

MID AMERICA / CHICAGO OFFICE

DATE : 10-Jul-99
PRICED BY : PMF
REV. NO. :

RE&C ACCT	DESCRIPTION	MANHOURS	LABOR	MATERIAL	SUBS	TOTAL	% TOTAL	% TOTAL '06'
01	IMPROVEMENTS TO SITE		$176,800	$265,200		$442,000	0.6%	2.6%
02	EARTHWORK		$348,100	$332,900		$681,000	1.0%	4.0%
03	CONCRETE		$1,110,200	$931,800		$2,042,000	2.9%	12.0%
05	STRUCTURAL STEEL		$1,968,700	$1,652,300		$3,621,000	5.2%	38.0%
06	PROCESS EQUIPMENT		$1,891,000	$15,127,000		$17,018,000	24.2%	100.0%
21	PIPING		$5,069,000	$4,461,000		$9,530,000	13.6%	56.0%
23	INSULATION		$484,100	$451,900		$936,000	1.3%	5.5%
24	INSTRUMENTATION & CONTROLS		$1,438,200	$3,837,800		$5,276,000	7.5%	31.0%
25	ELECTRICAL		$2,920,500	$1,844,500		$4,765,000	6.8%	28.0%
27	PAINTING		$593,500	$512,500		$1,106,000	1.6%	6.5%
40	BUILDINGS & ARCHITECTURAL		$0		$4,255,000	$4,255,000	6.1%	25.0%
	DIRECT FIELD COST	0	$16,000,100	$29,416,900	$4,255,000	$49,672,000	70.8%	308.6%
69	START-UP, TESTING AND TRAINING					Excluded	0.0%	0.0%
70	TEMPORARY FACILITIES					Included Above	0.0%	0.0%
70	CONSTRUCTION EQUIPMENT, TOOLS, SUPPLIES					Included Above	0.0%	0.0%
71	FIELD STAFF AND LEGALITIES					$2,553,000	3.6%	15.0%
	INDIRECT FIELD COST	0	$0	$0	$0	$2,553,000	3.6%	15.0%
	TOTAL FIELD COST	0	$16,000,100	$29,416,900	$4,255,000	$52,225,000	74.4%	323.6%
72	ENGINEERING (HOME OFFICE)					$5,617,000	8.0%	33.0%
	TOTAL FIELD AND HOME OFFICE					$57,842,000	82.4%	356.6%
	TAXES (Assume Tax Exempt Project)					$0	0.0%	0.0%
	INSURANCE					$204,000	0.3%	1.2%
	PERMITS					$26,000	0.0%	0.2%
	CRAFT CASUAL OVERTIME					$170,000	0.2%	1.0%
	CONTINGENCY					$10,551,000	15.0%	62.0%
	ESCALATION (Excluded)					$0	0.0%	0.0%
	SUBTOTAL					$68,793,000	98.0%	421.0%
	CM FEE					$1,400,000	2.0%	8.2%
	TOTAL (CONSTRUCTION COSTS THROUGH MECHANICAL COMPLETION)					$70,193,000	100.0%	429.2%

Please note that the cost estimates provided herein are dependent upon the basis of the quantities and pricing utilized to develop them, and upon the underlying assumptions, inclusions, and exclusions. Actual Project costs will differ, and can significantly affected by changes in the external environment, the manner in which the projects implemented, and other factors which impact the basis upon which the initial estimate was prepared or otherwise affect the project. Estimate accuracy ranges are projections based upon cost estimating methods and practices in accordance with ordinary standards of care normally practiced by recognized engineering firms in performing services of a similar nature. They are not a guarantee of actual project costs.

C. PRICED EQUIPMENT LIST

This is the list corresponding to the Process Plant Summary Construction Cost Estimate.

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
	RECEIVING & GRINDING									
BA-110	BIN ACTIVATOR	010		10						$19,000
BA-115	BIN ACTIVATOR	010		10						$19,000
BA-150	BIN ACTIVATOR	010		10						$19,000
BE-105	CORN UNLOADING BUCKET ELEVATOR	010		75	18,500	CFH				$60,000
BE-108	CORN SILO LOADING BUCKET ELEVATOR	010		100	18,500	CFH				$75,000
BE-121	CORN SILO DISCHARGE BUCKET ELEVATOR	010		20	4800	CFH				$35,000
BE-148	GROUND CORN BUCKET ELEVATOR	010		100						$75,000
BL-111	SILO FILTER FAN	010		2	900	CFM				w / DC-111
BL-112	SILO VENT FAN	010		1						$3,500
BL-116	SILO FILTER FAN	010		2	900	CFM				w / DC-116
BL-117	SILO VENT FAN	010		1						$3,500
BL-125	DUST COLLECTOR BLOWER	010		200	37,000	CFM				w / DC-125
BL-127	DUST COLLECTOR BLOWER	010		200	37,000	CFM				w / DC-127
BL-151	SILO FILTER FAN	010		1						$3,500
CL-106	CLEANING VIBRATOR SCREEN	010		30	18,500	CFH				$146,000
CL-107	DESTONER	010		20	50	TONS/HR				$43,000
CV-103	TRUCK UNLOADING CONVEYOR	010		25	18,500	CFH				$36,000
CV-109	CORN SILO LOADING CONVEYOR	010		25	18,500	CFH				$42,000
CV-120	CORN SILO DISCHARGE CONVEYOR	010		15	4800	CFH				$43,000
CV-122	CORN TRANSFER CONVEYOR	010		15	4800	CFH				$46,000
CV-140	RAW CORN SUPPLY CONVEYOR	010		15						$30,000
CV-141	CORN MILLING SUPPLY CONVEYOR	010		15						$60,000
CV-142	SIFTER	010		15						$100,000
CV-143	SIFTER	010		15						$100,000
CV-144	GROUND CORN DRAG CONVEYOR	010		15						$150,000
CV-147	GROUND CORN SCREW CONVEYOR	010		30	10 - 50	TONS/HR			VARIABLE SPEED	$25,000
CV-152	GROUND CORN SUPPLY CONVEYOR	010		30						$25,000
DC-111	SILO FILTER	010		NA						$7,000
DC-116	SILO FILTER	010		NA						$7,000
DC-125	DUST COLLECTOR	010		NA						$80,000
DC-127	DUST COLLECTOR	010		NA						$23,000
DC-151	DUST COLLECTOR	010		NA						$7,000
M-145	HAMMERMILL	010		125	10	TONS/HR				$135,000
M-146	HAMMERMILL	010		125	10	TONS/HR				$135,000
MM-145	MILL MAGNET	010		1	10	TONS/HR				$10,000
MM-146	MILL MAGNET	010		1	10	TONS/HR				$10,000
MS-104	UNLOADING MAGNET	010		NA						$10,000
RV-126	ROTARY DISCHARGE VALVE	010		0.75						w / DC-125
RV-128	ROTARY DISCHARGE VALVE	010		0.75						w / DC-127
SL-101	CORN TRUCK SCALE	010		NA						
TK-102	TRUCK UNLOADING HOPPER	010		NA						$18,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Use, reproduction, or disclosure is subject to restrictions set forth in Contract No. DE-AC36-GO10337 (and Subcontract TA029/SC01) with New York State Technology Enterprise Corporation.

Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
TK-110	CORN STORAGE SILO	010		NA	100,000	CF	40'-0"	110'-0"		$292,000
TK-115	CORN STORAGE SILO	010		NA	100,000	CF	40'-0"	110'-0"		$292,000
TK-150	GROUND CORN STORAGE	010		NA	1500	CF				$42,000
	HYDROLYSIS								Subtotal	$2,226,500
AG-201	SLURRY TANK AGITATOR	020	304 SS	40					TURBINE	$20,000
AG-205A	1ST HOLD TANK AGITATOR A	020	304 SS	5					TURBINE	$10,000
AG-205B	1ST HOLD TANK AGITATOR B	020	304 SS	5					TURBINE	$10,000
AG-205C	1ST HOLD TANK AGITATOR C	020	304 SS	5					TURBINE	$10,000
AG-215A	2ND HOLD TANK AGITATOR A	020	304 SS	5						$10,000
AG-215B	2ND HOLD TANK AGITATOR B	020	304 SS	5						$10,000
AG-215C	2ND HOLD TANK AGITATOR C	020	304 SS	5						$10,000
AG-215D	2ND HOLD TANK AGITATOR D	020	304 SS	5						$10,000
AG-215E	2ND HOLD TANK AGITATOR E	020	304 SS	5						$10,000
AG-230	MIX TANK AGITATOR	020	304 SS	2					TOP ENTERING	$5,000
AG-240	SACCHARIFICATION TANK AGITATOR	020	304 SS	15					SIDE ENTERING	$12,000
AG-241	SACCHARIFICATION TANK AGITATOR	020	304 SS	15					SIDE ENTERING	$12,000
AG-250	YEAST PROPAGATION TANK AGITATOR	020	304 SS	3					VARIABLE SPEED, SINGLE MECH. SEAL	$13,000
AG-265	ANTIFOAM TANK AGITATOR	020	316 SS	1					SINGLE MECHANICAL SEAL	$7,000
E-207	HOLDING COIL	020	304 SS	NA						$20,000
EX-212	VAPOR CONDENSER	020	4 SS TUBE	NA					SHELL & TUBE	$20,000
EX-222	VAPOR CONDENSER	020	4 SS TUBE	NA					SHELL & TUBE	$20,000
EX-242	MASH COOLER	020		NA					PLATE & FRAME	$90,000
EX-243	MASH COOLER	020		NA					PLATE & FRAME	$90,000
F-251	AIR PRE-FILTER	020	316 SS	NA	50	LB/HR			CARTRIDGE, 8 MICRONS	$2,000
F-252	AIR STERILE FILTER	020	316 SS	NA	50	LB/HR			CARTRIDGE, 0.2 MICRONS ABSOLUTE	$2,000
F-253	STEAM FILTER	020	316 SS	NA	600	LB/HR			CARTRIDGE, 1.5 MICRONS ABSOLUTE	$4,000
JC-206	JET COOKER	020	316 SS	NA						$26,000
PU-205A	1ST HOLD PUMP A	020	CD4M	200	800	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-205B	1ST HOLD PUMP B	020	CD4M	200	800	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-215A	2ND HOLD PUMP A	020	CD4M	30	800	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-215B	2ND HOLD PUMP B	020	CD4M	30	800	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-221A	MASH PUMP A	020	CD4M	25	800	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-221B	MASH PUMP B	020	CD4M	25	800	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-230A	MIX TANK PUMP A	020	CD4M	50		GPM		100 FT. TDH	PD	$5,000
PU-230B	MIX TANK PUMP B	020	CD4M	50		GPM		100 FT. TDH	PD	$5,000
PU-240A	SACCHARIFICATION TANK PUMP A	020	CD4M	75	1300	GPM		100 FT. TDH	CENTRIFUGAL	$10,000
PU-240B	SACCHARIFICATION TANK PUMP B	020	CD4M	75	1300	GPM		100 FT. TDH	CENTRIFUGAL	$10,000
PU-250	YEAST PROPAGATION TANK PUMP	020	316 SS	7.5	150	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$5,000
PU-255	AG ENZYME METERING PUMP	020	316 SS	0.5	25	GPM			METERING	$5,000
PU-260	ALPHA AMYLASE METERING PUMP	020	316 SS	0.5	15	GPM			METERING	$5,000
PU-265	ANTIFOAM AGENT PUMP	020	316 SS	15	15	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$3,000
PU-266	ANTIFOAM DRUM PUMP	020	316 SS	NA					AIR OPERATED DOUBLE DIAPHRAGM	$3,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
TK-201	SLURRY TANK	020	304 SS	NA	20,000	GAL	13'-0"	22'-0"	CONE TOP, FLAT BOTTOM	$50,000
TK-205	1ST HOLDING TANK	020	304 SS	NA	25,000	GAL	13'-0"	26'-0"	HORIZONTAL, 4 COMPARTMENTS	$65,000
TK-210	FLASH COOLER A	020	304 SS	NA	3,500	GAL	8'-0"	10'-0"	DISHED TOP, CONE BOTTOM	$15,000
TK-211	FLASH COOLER B	020	304 SS	NA	13,000	GAL	12'-0"	16'-0"	DISHED HEADS	$15,000
TK-215	2ND HOLDING TANK	020	304 SS	NA	52,800	GAL	15'-0"	40'-0"	HORIZONTAL	$75,000
TK-220	FLASH COOLER	020	304 SS	NA	5,700	GAL	9'-0"	12'-0"	DISHED TOP, CONE BOTTOM	$15,000
TK-230	MIX TANK	020	CS (LINED)	NA	6,000	GAL	8'-0"	16'-0"	VERTICAL, DISHED HEADS	$50,000
TK-240	SACCHARIFICATION TANK	020	CS (LINED)	NA	87,000	GAL	20'-0"	37'-0"	DISHED TOP, SLOPED BOTTOM	$115,000
TK-241	SACCHARIFICATION TANK	020	CS (LINED)	NA	87,000	GAL	20'-0"	37'-0"	DISHED TOP, SLOPED BOTTOM	$115,000
TK-250	YEAST PROPAGATION TANK	020	304L SS	NA	12,350	GAL	10'-0"	20'-0"	VERTICAL, DISHED HEADS, 45 PSIG/FV, JKT	$87,000
TK-255	AG ENZYME TANK	020	FRP	NA	7,000	GAL	8'-0"	20'-0"	VERTICAL, DISHED HEADS	$20,000
TK-260	ALPHA AMYLASE TANK	020	FRP	NA	6,000	GAL	8'-0"	16'-0"	VERTICAL CYLINDRICAL	$20,000
TK-265	ANTIFOAM TANK	020	304L SS	NA	1600	GAL	6'-0"	8'-0"	DISHED HEADS, +12" / -12" W.C.	$20,000
VP-225	VACUUM PUMP PACKAGE	020		30	900	ACFM			LIQUID RING, 24.3" Hg VACUUM	$40,000
	FERMENTATION								Subtotal	$1,212,000
AG-301	SEED FERMENTER A AGITATOR	030	316 SS	15					DOUBLE MECH. SEAL	$8,000
AG-305	PRE-FERMENTER A AGITATOR	030	316 SS	25					DOUBLE MECH. SEAL	$11,000
AG-310	SEED FERMENTER B AGITATOR	030	316 SS	15					DOUBLE MECH. SEAL	$8,000
AG-315	PRE-FERMENTER B AGITATOR	030	316 SS	25					DOUBLE MECH. SEAL	$11,000
AG-320	FERMENTER #1 AGITATOR	030	316 SS	50					DOUBLE MECH. SEAL	$12,000
AG-325	FERMENTER #2 AGITATOR	030	316 SS	50					DOUBLE MECH. SEAL	$12,000
AG-330	FERMENTER #3 AGITATOR	030	316 SS	50					DOUBLE MECH. SEAL	$12,000
AG-335	BEER WELL AGITATOR	030	304 SS	10						$12,000
C-341	CO2 COMPRESSOR	030	CAST IRON	150	3250	ICFM			VARIABLE SPEED	$115,000
EX-302	SEED FERMENTER A COOLER	030		NA					PLATE & FRAME	$14,000
EX-306	PRE-FERMENTER A COOLER	030		NA					PLATE & FRAME	$18,000
EX-311	SEED FERMENTER B COOLER	030		NA					PLATE & FRAME	$14,000
EX-316	PRE-FERMENTER B COOLER	030		NA					PLATE & FRAME	$18,000
EX-321	FERMENTER #1 COOLER	030		NA					PLATE & FRAME	$18,000
EX-326	FERMENTER #2 COOLER	030		NA					PLATE & FRAME	$18,000
EX-331	FERMENTER #3 COOLER	030		NA					PLATE & FRAME	$18,000
PU-301	SEED FERMENTER A PUMP	030	316 SS	40	600	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$9,000
PU-305	PRE-FERMENTER A PUMP	030	316 SS	75	1400	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$13,000
PU-310	SEED FERMENTER B PUMP	030	316 SS	40	600	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$9,000
PU-315	PRE-FERMENTER B PUMP	030	316 SS	75	1400	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$13,000
PU-320	FERMENTER #1 PUMP	030	316 SS	125	2250	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$12,000
PU-325	FERMENTER #2 PUMP	030	316 SS	125	2250	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$12,000
PU-330	FERMENTER #3 PUMP	030	316 SS	125	2250	GPM		100 FT. TDH	CENTRIFUGAL, DBL MECH. SEAL	$12,000
PU-335	BEER WELL PUMP	030	304 SS	35					CENTRIFUGAL	$12,000
TK-301	SEED FERMENTER (TRAIN A)	030	304L SS	NA	95,000	GAL	22'-0"	40'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$150,000
TK-305	PRE-FERMENTER (TRAIN A)	030	304L SS	NA	190,000	GAL	30'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$210,000
TK-310	SEED FERMENTER (TRAIN B)	030	304L SS	NA	95,000	GAL	22'-0"	40'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$150,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

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Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
TK-315	PRE-FERMENTER (TRAIN B)	030	304L SS	NA	190,000	GAL	30'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$210,000
TK-320	FERMENTER #1	030	304L SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$250,000
TK-325	FERMENTER #2	030	304L SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$250,000
TK-330	FERMENTER #3	030	304L SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM, 2.5"/12"VAC.	$250,000
TK-335	BEER WELL	030	304 SS	NA	380,000	GAL	40'-0"	42'-0"	CONE TOP, SLOPED BOTTOM	$250,000
V-340	CO2 SCRUBBER	030	304 SS	NA					5 PSIG / 20" W.C. VAC.	$30,000
	DISTILLATION & RECTIFICATION								Subtotal	$2,161,000
C-417	MASH COLUMN VACUUM PUMP	040		30	700	CFM				$40,000
C-420	DEHYDRATION VACUUM PUMP	040		10	250	CFM				$40,000
EX-402	MASH COLUMN REBOILER	040		NA					SHELL & TUBE	$165,000
EX-403	MASH PREHEATER #1	040		NA					SHELL & TUBE	$95,000
EX-404	MASH COLUMN AFTER CONDENSER	040		NA					PLATE & FRAME	$137,000
EX-411	RECTIFICATION COLUMN REBOILER	040		NA					SHELL & TUBE	$20,000
EX-412	RECTIFICATION FEED HEATER	040		NA					PLATE & FRAME	$10,000
EX-413	FUSEL COOLER	040		NA					PLATE & FRAME	$5,000
EX-416	VACUUM PUMP COOLER #1	040		NA					SHELL & TUBE	$20,000
EX-419	VACUUM PUMP COOLER #2	040		NA					SHELL & TUBE	$20,000
EX-432	VAPOR HEATER	040		NA					SHELL & TUBE	$10,000
EX-433	REGEN. MAIN CONDENSER	040		NA					PLATE & FRAME	$43,000
EX-441	PRODUCT COOLER	040		NA					PLATE & FRAME	$20,000
EX-442	CONDENSER	040		NA					PLATE & FRAME	$20,000
PU-401A	MASH COLUMN RECYCLE PUMP	040	316 SS	100	7000	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$29,000
PU-401B	STILLAGE PUMP	040	316 SS	30	700	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$10,000
PU-405	RECTIFICATION REFLUX TANK PUMP	040	316 SS	25	400	GPM		100 FT. TDH	CENTRIFUGAL	$6,000
PU-406	RECTIFICATION FEED TANK PUMP	040	316 SS	7.5	150	GPM		100 FT. TDH	CENTRIFUGAL	$4,000
PU-410	STILLAGE WATER PUMP	040	316 SS	7.5	300	GPM		100 FT. TDH	CENTRIFUGAL	$7,000
PU-425	WATER REFLUX TANK PUMP	040	316 SS	5	50	GPM		100 FT. TDH	CENTRIFUGAL	$4,000
PU-434	REGEN. REFLUX TANK PUMP	040	316 SS	3	25	GPM		100 FT. TDH	CENTRIFUGAL	$3,000
PU-440	PRODUCT TANK PUMP	040	316 SS	7.5	100	GPM		100 FT. TDH	CENTRIFUGAL	$4,000
TK-405	RECTIFICATION REFLUX TANK	040	304L SS	NA	2250	GAL	6'-0"	12'-0"	50 PSIG / FV	$23,000
TK-406	RECTIFICATION FEED TANK	040	304L SS	NA	1250	GAL	5'-0"	10'-0"	45 PSIG / FV	$20,000
TK-407	VAPOR-LIQUID SEPARATOR	040		NA						$15,000
TK-425	WATER REFLUX TANK	040		NA	300	GAL	3'-0"	6'-0"	ATMOSPHERIC	$13,000
TK-434	REGEN. REFLUX TANK	040		NA	200	GAL	2'-6"	5'-0"	45 PSIG / FV	$13,000
TK-440	PRODUCT TANK	040		NA	1250	GAL	5'-0"	10'-0"		$21,000
V-401	MASH COLUMN	040		NA					VERTICAL, 50 PSIG	$204,000
V-410A	RECTIFICATION COLUMN LOWER SECTION	040		NA						w / V-410B
V-410B	RECTIFICATION COLUMN UPPER SECTION	040		NA						$160,000
V-415	CO2 STRIPPER	040		NA	185	GAL				$22,000
V-418	WATER SEPARATION VESSEL	040		NA	35	GAL	1'-6"	3'-0"		w / C-417
V-426	FUSEL DECANTER	040		NA	125	GAL	2'-0"	5'-0"		$9,000
V-430	MOLECULAR SIEVE	040		NA					45 PSIG / FV	$400,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity		Diam.	Height/Head	Misc.	Estimated Cost
					Vol/Flow	Gal/Gpm				
V-431	MOLECULAR SIEVE	040		NA					45 PSIG / FV	$400,000
X-401	MASH COLUMN INTERNALS	040		NA						$50,000
X-410	RECTIFICATION COLUMN UPPER / LOWER INTERNALS	040		NA						$200,000
X-415	CO2 STRIPPER INTERNALS	040		NA						$15,000
									Subtotal	$2,277,000
	THIN STILLAGE & WDGS									
AG-510	THIN STILLAGE TANK AGITATOR	050	316 SS	10					DOUBLE MECH. SEAL	$8,000
AG-515	CONCENTRATE TANK AGITATOR	050	316 SS	5					SINGLE MECH. SEAL	$18,000
PU-505	DECANTER OVERFLOW TANK PUMP	050	316 SS	30	700	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$5,000
PU-510A	EVAPORATOR FEED PUMP	050	316 SS	50	350	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$6,000
PU-510B	THIN STILLAGE RECYCLE PUMP	050	316 SS	40	450	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$6,000
PU-515	CONCENTRATE TANK PUMP	050	316 SS	5		GPM		100 FT. TDH	DOUBLE MECH. SEAL	$8,000
SE-501	DECANTER #1	050		320					270 HP & 50 HP MOTORS	$600,000
SE-502	DECANTER #2	050		320					270 HP & 50 HP MOTORS	$600,000
SE-503	DECANTER #3	050		320					270 HP & 50 HP MOTORS	$600,000
TK-505	DECANTER OVERFLOW TANK	050	304L SS	NA	8000	GAL	9'-0"	16'-0"	DISHED HEADS, +12" / -12" W.C.	$26,000
TK-510	THIN STILLAGE TANK	050	304L SS	NA	32,000	GAL	14'-0"	28'-0"	CONE TOP, SLOPED BOTT.,0.29 PSIG/-12"W.C.	$52,000
TK-515	CONCENTRATE TANK	050	304L SS	NA	32,000	GAL	14'-0"	28'-0"	CONE TOP, SLOPED BOTT.,0.29 PSIG/-12"W.C.	$54,000
									Subtotal	$1,983,000
	EVAPORATION									
C-620	MVR COMPRESSOR	060		1000						w / E-601
E-601	EVAPORATOR CHEST A	060		NA						$1,750,000
E-610	EVAPORATOR CHEST B	060	304L / 316L	NA					SHELL & TUBE	w / E-601
HE-630	EVAP. FEED PRE-HEATER	060	304L / 316L	NA					SHELL & TUBE	w / E-601
PU-601A	EVAPORATOR A FIRST PASS RECYCLE PUMP	060		125	3300	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-601B	EVAPORATOR A SECOND PASS RECYCLE PUMP	060		75	1600	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-610A	EVAPORATOR B FIRST PASS RECYCLE PUMP	060		125	3300	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-610B	EVAPORATOR B SECOND PASS RECYCLE PUMP	060		75	1600	GPM		100 FT. TDH	CENTRIFUGAL	w / E-601
PU-625	EVAP. CONDENSATE PUMP	060		25						w / E-601
TK-605	EVAPORATOR VAPOR SEPARATOR A	060	304L SS	NA	30,000	GAL	14'-0"	25'-0"	DISHED HEADS, 15 PSIG / FV	w / E-601
TK-615	EVAPORATOR VAPOR SEPARATOR B	060	304L SS	NA	30,000	GAL	14'-0"	25'-0"	DISHED HEADS, 15 PSIG / FV	w / E-601
TK-625	EVAP. CONDENSATE TANK	060		NA						w / E-601
									Subtotal	$1,750,000
	PRODUCT LOADOUT									
BL-730	DUST COLLECTOR EXHAUST BLOWER	070		125						$40,000
CV-735	DDGS STORAGE CONVEYOR	070	CS	20	2000	CFH				$125,000
CV-736	DDGS RECLAIM CONVEYOR	070		75	12,000	CFH				$120,000
DC-725	DUST COLLECTOR	070		NA						$28,000
EX-704	ETHANOL VAPOR RECOVERY PACKAGE	070								$50,000
F-731	DUST COLLECTOR SAFETY AIR FILTER	070		NA						W / BL-730
LA-712	ETHANOL / GASOLINE PRODUCT LOADING ARM	070		NA						$10,000
MH-739	DDGS ROTARY TYPE POSITIONER	070		0.75	12,000	CFH				W / MH-740
MH-740	DDGS RETRACTABLE LOADING SPOUT	070		0.75	12,000	CFH				$16,500
MI-720	PADDLE MIXER	070		60						$61,000
MX-703	ETHANOL / GASOLINE IN-LINE MIXER	070		NA					STATIC	$3,500

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Capacity Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
PU-701A	ETHANOL CHECK TANK PUMP A	070	316 SS	15	250	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$2,500
PU-701B	ETHANOL CHECK TANK PUMP B	070	316 SS	15	250	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$2,500
PU-703	OFF-SPEC ETHANOL FEED PUMP	070	316 SS	20					CENTRIFUGAL	$2,500
PU-710A	GASOLINE STORAGE TANK PUMP A	070	316 SS	3	5	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$2,000
PU-710B	GASOLINE STORAGE TANK PUMP B	070	316 SS	3	5	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$2,000
PU-711	ETHANOL PRODUCT TANK PUMP	070	316 SS	50	750	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$5,500
RV-725	DUST COLLECTOR ROTARY AIRLOCK	070		1.5						$8,500
SL-730A	BLOWER SILENCER A	070		NA						W / BL-730
SL-730B	BLOWER SILENCER B	070		NA						W / BL-730
SL-741	DDGS TRUCK SCALE	070		NA						
TK-701	ETHANOL CHECK TANK A	070	CS	NA	17,000	GAL	13'-0"	17'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -1.5" W.C.	$21,000
TK-702	ETHANOL CHECK TANK B	070	CS	NA	17,000	GAL	13'-0"	17'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -1.5" W.C.	$21,000
TK-703	OFF-SPEC ETHANOL TANK	070	CS	NA					CONE TOP, FLAT BOTTOM	$21,000
TK-710	GASOLINE STORAGE TANK	070	CS	NA	60,000	GAL	18'-0"	35'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -1.5" W.C.	$95,000
TK-711	ETHANOL PRODUCT TANK	070	CS	NA	600,000	GAL	44'-0"	55'-0"	FLAT TOP, CONE BOTTOM, +2.5" / -1.5" W.C.	$240,000
									Subtotal	$877,500
	WASTE WATER TREATMENT									
AG-815A	NEUTRALIZATION TANK AGITATOR #1	080		5						$12,000
AG-815B	NEUTRALIZATION TANK AGITATOR #2	080		5						$12,000
EX-821	CIP HEATER	080		NA					SHELL & TUBE	$10,000
PU-801	H2O2 PUMP	080	316 SS	NA	35	LB/HR			AIR OPERATED DOUBLE DIAPHRAGM	$4,000
PU-802	H3PO4 PUMP	080	316 SS	NA	20	LB/HR			AIR OPERATED DOUBLE DIAPHRAGM	$4,000
PU-805	NaOH STORAGE TANK PUMP	080	316 SS	7.5	10	GPM		100 FT. TDH	CENTRIFUGAL, DOUBLE MECH. SEAL	$2,000
PU-810	H2SO4 STORAGE TANK PUMP	080	316 SS	7.5	25	GPM		100 FT. TDH		$2,000
PU-816	SULFURIC ACID METERING PUMP	080		0.5					METERING	$7,000
PU-820	CIP PUMP	080	316 SS	150		GPM			CENTRIFUGAL, DOUBLE MECH. SEAL	$12,000
TK-805	50% CAUSTIC STORAGE TANK	080	CS	NA	9000	GAL	10'-0"	16'-0"	VERTICAL, DISHED HEADS	$16,000
TK-810	H2SO4 STORAGE TANK	080	CS	NA	9000	GAL	10'-0"	16'-0"	HORIZONTAL, +1 PSIG / -12" W.C.	$22,000
TK-815	NEUTRALIZATION TANK	080	304L SS	NA	15,000	GAL	13'-0"x13'-0"	12'-0"	2 COMPARTMENTS, +12" / -12" W.C.	$57,000
TK-820	CIP TANK	080	304L SS	NA	35,000	GAL	17'-0"x17'-0"	17'-0"	RECTANGULAR, 3 COMPARTMENTS	$61,000
TK-830	AERATED WASTEWATER TREATMENT SYSTEM	080								$150,000
									Subtotal	$371,000
	UTILITIES									
B-901	UTILITY BOILER	090		200	72,500	LB/HR			150 PSIG	$450,000
B-902	UTILITY BOILER	090		200	72,500	LB/HR			150 PSIG	$450,000
C-950A	AIR COMPRESSOR A	090		300	1000	SCFM			130 PSIG DISCH. PRESSURE	$87,000
C-950B	AIR COMPRESSOR B	090		300	1000	SCFM			130 PSIG DISCH. PRESSURE	$87,000
CT-930	COOLING TOWER THREE (3) CELL	090		300	12,000	GPM			(2) 150 HP REVERSIBLE FANS	$400,000
DA-903	BOILER DEAERATOR	090	CS	NA	150,000	LB/HR			50 PSIG	$29,000
DR-952	AIR DRYER PACKAGE	090		NA	1000	SCFM			DEWPOINT -60 F	$15,000
EX-916	MAKE-UP WATER PREHEATER	090		NA					SHELL & TUBE	$13,500
J-905	DESUPERHEATER	090		NA						$10,000
PU-903A	BOILER FEED WATER PUMP A	090		150	350	GPM		100 FT. TDH	CENTRIFUGAL	$50,000
PU-903B	BOILER FEED WATER PUMP B	090		150	350	GPM		100 FT. TDH	CENTRIFUGAL	$50,000

EQUIPMENT LIST
30 MM GAL/YR CORN TO ETHANOL FACILITY

Use, reproduction, or disclosure is subject to restrictions set forth in Contract No. DE-AC36-GO10337 (and Subcontract TA029/SC01) with New York State Technology Enterprise Corporation.

Equipment No.	Equipment Name	PFD	Mat'l OF Const	Est. HP	Capacity Vol/Flow	Gal/Gpm	Diam.	Height/Head	Misc.	Estimated Cost
PU-915A	SOFTENED WATER PUMP A	090	316 SS	10	60	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	$2,000
PU-915B	SOFTENED WATER PUMP B	090	316 SS	10	60	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	$2,000
PU-921A	DESUPERHEATER CONDENSATE PUMP	090	316 SS	7.5	20	GPM		100 FT. TDH	CENTRIFUGAL	$4,000
PU-921B	LP CONDENSATE FLASH TANK PUMP A	090	316 SS	25	360	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	$5,000
PU-921C	LP CONDENSATE FLASH TANK PUMP B	090	316 SS	25	360	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	$5,000
PU-930A	COOLING WATER PUMP A	090		300	6,000	GPM		100 FT. TDH	VERTICAL TURBINE	$21,000
PU-930B	COOLING WATER PUMP B	090		300	6,000	GPM		100 FT. TDH	VERTICAL TURBINE	$21,000
PU-930C	COOLING WATER PUMP C	090		300	6,000	GPM		100 FT. TDH	VERTICAL TURBINE	$21,000
PU-931A	SULFURIC ACID INJECTION PUMP A	090		0.25	5	GPH		100 FT. TDH	METERING	$4,000
PU-931B	SULFURIC ACID INJECTION PUMP B	090		0.25	5	GPH		100 FT. TDH	METERING	$4,000
PU-960A	SEAL WATER RECIRCULATING PUMP	090	316 SS	15	50	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	$2,500
PU-960B	STANDBY RECIRCULATING PUMP	090	316 SS	15	50	GPM		100 FT. TDH	CENTRIFUGAL, SINGLE MECH. SEAL	$2,500
TK-915	SOFTENED WATER TANK	090	FRP	NA	22,500	GAL	12'-0"	26'-0"	CONE TOP, FLAT BOTTOM, +2.5" / -2.5" W.C.	$33,000
TK-920	CONVERTER CONDENSATE FLASH TANK	090	CS	NA	1250	GAL	5'-0"	8'-0"	VERTICAL, DISHED HEADS, 25 PSIG / FV	$9,000
TK-921	LP CONDENSATE FLASH TANK	090	CS	NA	10,500	GAL	11'-0"	14'-0"	VERTICAL, DISHED HEADS, 14.9 PSIG / FV	$24,000
TK-960	SEAL WATER TANK	090	304L SS	NA	600	GAL	4'-0"	6'-0"	VERTICAL, DISHED HEADS, +12" / -12" W.C.	$13,500
V-904	BLOWDOWN TANK	090		NA	1200	GAL	4'-0"	12'-0"	VERTICAL, DISHED HEADS, +12" / -12" W.C.	$9,000
V-951	AIR RECEIVER	090		NA	1150	CF	7'-0"	30'-0"	VERTICAL, DISHED HEADS	$40,000
WF-910	WATER SOFTENER PACKAGE	090		NA						$40,000
		Est. Total Hp		9,133	6,804	KW			Subtotal	$1,904,000
	CHUTES & DUCT ALLOWANCES									$200,000
									TOTAL	$14,762,000

D. PLANT OPERATING COST ESTIMATE

This estimate fits the plant. Please notice the price of the enzymes. These are not translatable to the biomass alcohol plant.

ESTIMATED OPERATING COSTS AND REVENUES

ANNUAL OPERATING COSTS WITH ENZYME FERMENTATION			
Corn	12,000,000 Bu/year	$2.80 Bu	$33,600,000
Labor			$5,147,550
Operating Supplies			$350,000
Maintenance Materials			$983,100
Lubricants			$6,000
Laboratory Chemicals			$48,000
Operating Chemicals			
H2SO4	154 pounds/hr	$0.03	$33,634
NH3	51 pounds/hr	$0.11	$44,982
Antifoam	8 pounds/hr	$10.00	$672,000
Gasoline	178 gal/hr	$0.60	$897,120
Water	49 cu.ft./hr	$0.67	$273,521
Natural Gas	24 MMBTU/hr	$1.86	$374,976
BFW Chemicals	2 pounds/hr	$0.97	$17,926
CW Chemicals	11 pounds/hr	$1.00	$92,400
Ammonium Phosphate	5 pounds/hr	$0.66	$27,720
Urea	5 pounds/hr	$0.21	$8,820
NAOH	80 pounds/hr	$0.17	$110,880
H3PO4	11 pounds/hr	$0.37	$34,188
H2O2	22 pounds/hr	$0.50	$91,476
Novo Ban 240L	22 pounds/hr	$5.00	$924,000
Novo Ban AMG 300L	60 pounds/hr	$5.40	$2,721,600
Novozym 188	24 pounds/hr	$21.00	$4,233,600
Econase CE15	50 pounds/hr	$3.80	$1,596,000
Electricity	7,800 kw/hr	$0.040 /kwh	$2,620,800
TOTAL COSTS			$54,910,292

ANNUAL OPERATING REVENUES			
Alcohol	30,000,000 gal/yr	$1.65 per gal	$49,500,000
WDGS@60% moisture	216,000 tons/yr	$85.00 /ton	$18,360,000
TOTAL REVENUES			$67,860,000
CASH FLOW			$12,949,708

E. PLANT LABOR ESTIMATE

There are some of the same basic jobs and costs here as associated with the biomass plant. The difference is in the receiving of the feedstock and the shipping of the by-product for the corn plant.

Project 78849.001
NYSTEC

ESTIMATED PLANT LABOR COST
FOR CORN TO ETHANOL FACILITY

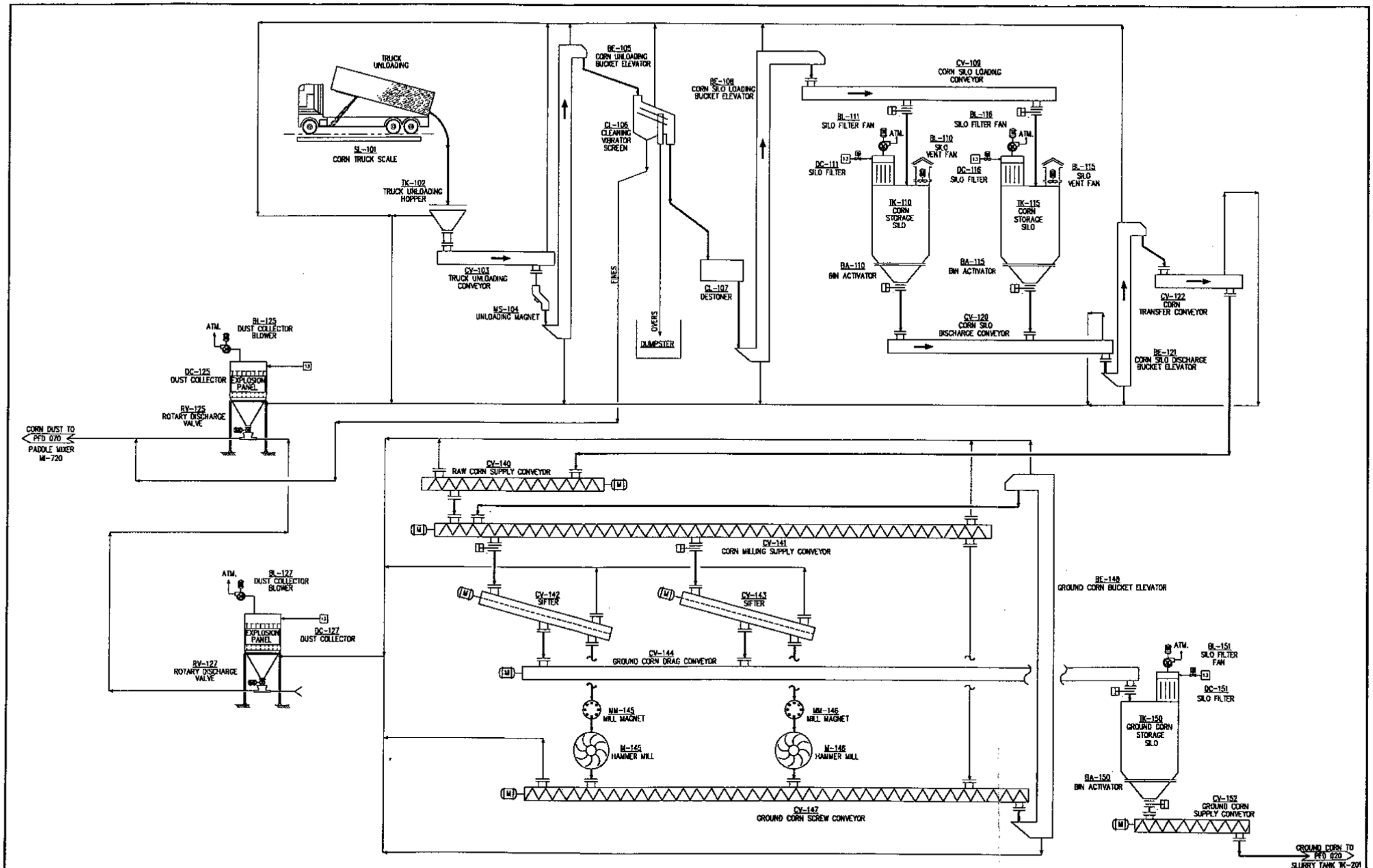
Rev. A, 7/22/99

Staffing	No. of People	Rate (W2)	Salary	Cost w/benefits 1.23
Plant Manager	1	$ 62.50	$125,000	$153,750
Secretary	1	$ 20.00	$40,000	$49,200
Human Resources Manager	1	$ 40.00	$80,000	$98,400
Clerk	1	$ 25.00	$50,000	$61,500
Accounting Manager	1	$ 45.00	$90,000	$110,700
Clerk	1	$ 15.00	$30,000	$36,900
Check Writer	1	$ 20.00	$40,000	$49,200
Senior Plant Engineer	1	$ 40.00	$80,000	$98,400
Plant Engineer	1	$ 35.00	$70,000	$86,100
QC Manager	1	$ 45.00	$90,000	$110,700
Senior Chemist	1	$ 35.00	$70,000	$86,100
Chemists	4	$ 25.00	$200,000	$246,000
Utility	4	$ 15.00	$120,000	$147,600
Procurement Manager	1	$ 35.00	$70,000	$86,100
Logistics Manager	1	$ 55.00	$110,000	$135,300
Supervisors	2	$ 35.00	$140,000	$172,200
Clerks	1	$ 15.00	$30,000	$36,900
Shipping & Receiving Manager	1	$ 35.00	$70,000	$86,100
Guards	8	$ 20.00	$320,000	$393,600
Shipping & Receiving Utility	2	$ 20.00	$80,000	$98,400
Operations Manager	1	$ 55.00	$110,000	$135,300
Shift Supervisors	4	$ 30.00	$240,000	$295,200
Control Room Operators	8	$ 25.00	$400,000	$492,000
Licensed Boiler Operators	4	$ 30.00	$240,000	$295,200
Utilities	4	$ 15.00	$120,000	$147,600
WDGS Operators	4	$ 20.00	$160,000	$196,800
WWT operators	1	$ 20.00	$40,000	$49,200
Maintenance Supervisor	1	$ 45.00	$90,000	$110,700
Mechanical	4	$ 30.00	$240,000	$295,200
Welders	4	$ 30.00	$240,000	$295,200
Electrical	4	$ 30.00	$240,000	$295,200
Utilities	4	$ 20.00	$160,000	$196,800
Totals	78	$ 26.83	$4,185,000	$5,147,550

F. PROCESS FLOW DIAGRAMS

These are the related process flow diagrams. Physical depictions of process equipment are not necessarily accurately represented.

PFD010 – Corn Receiving, Storage, & Milling
PFD020 – Liquefaction & Saccharification
PFD030 – Fermentation
PFD040 – Distillation
PFD050 – Stillage Decanters
PFD060 – Evaporation
PFD070 – Product Storage System
PFD080 – Storage Tanks, CIP, & Neutralization System
PFD090 – Utility System



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV NO.	DATE	REVISION	BY	REAG APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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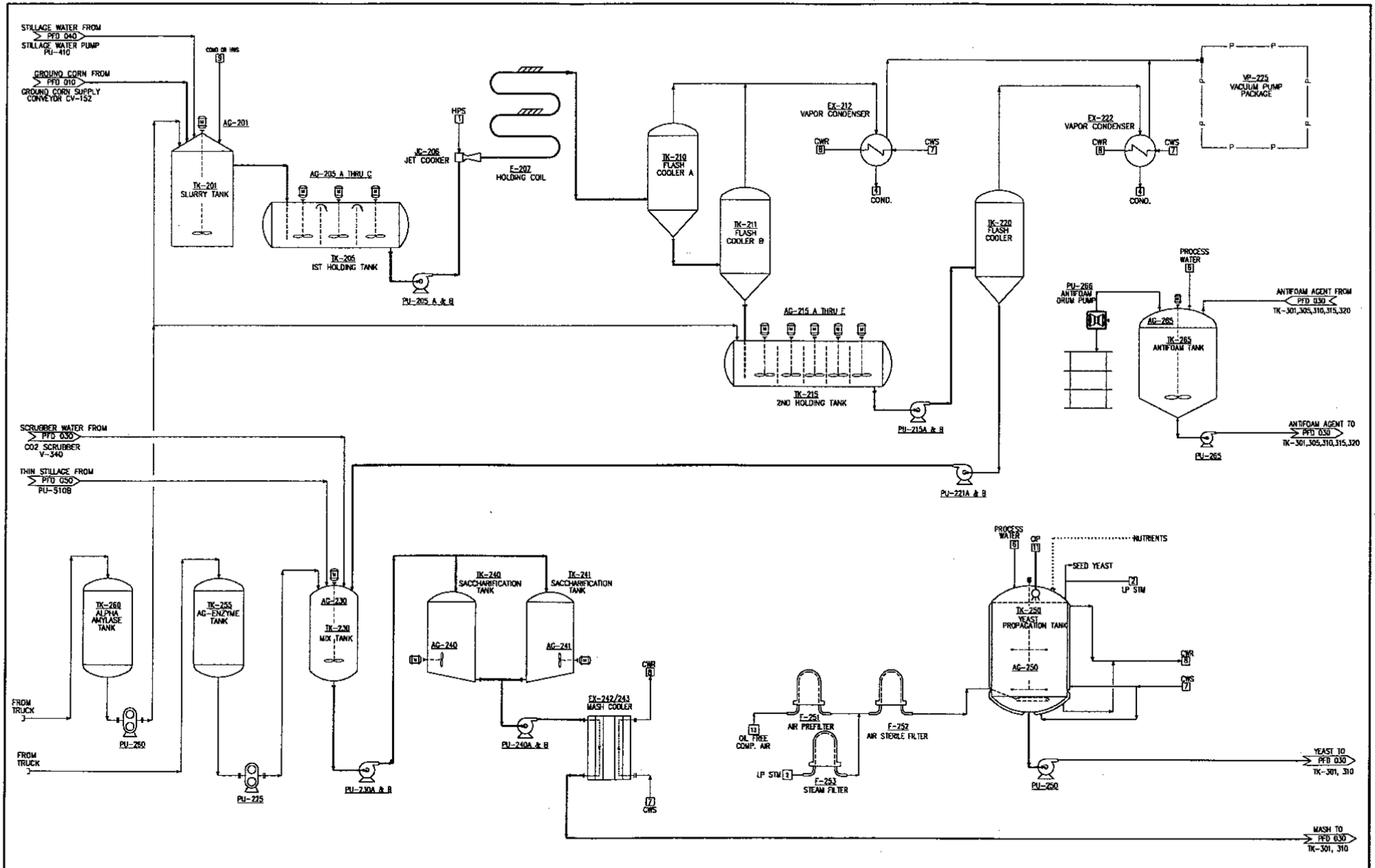
DRAWN: RBP DATE: 05/12/98
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM – DRY MILL
CORN RECEIVING, STORAGE & MILLING

PROJECT NUMBER: 78849.001
DRAWING NUMBER: PFD010
REVISION: A
SCALE: NONE



UTILITY LEGEND	
1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 OP SUPPLY
3 HP CONDENSATE	12 OP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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DOWNERS GROVE, ILLINOIS

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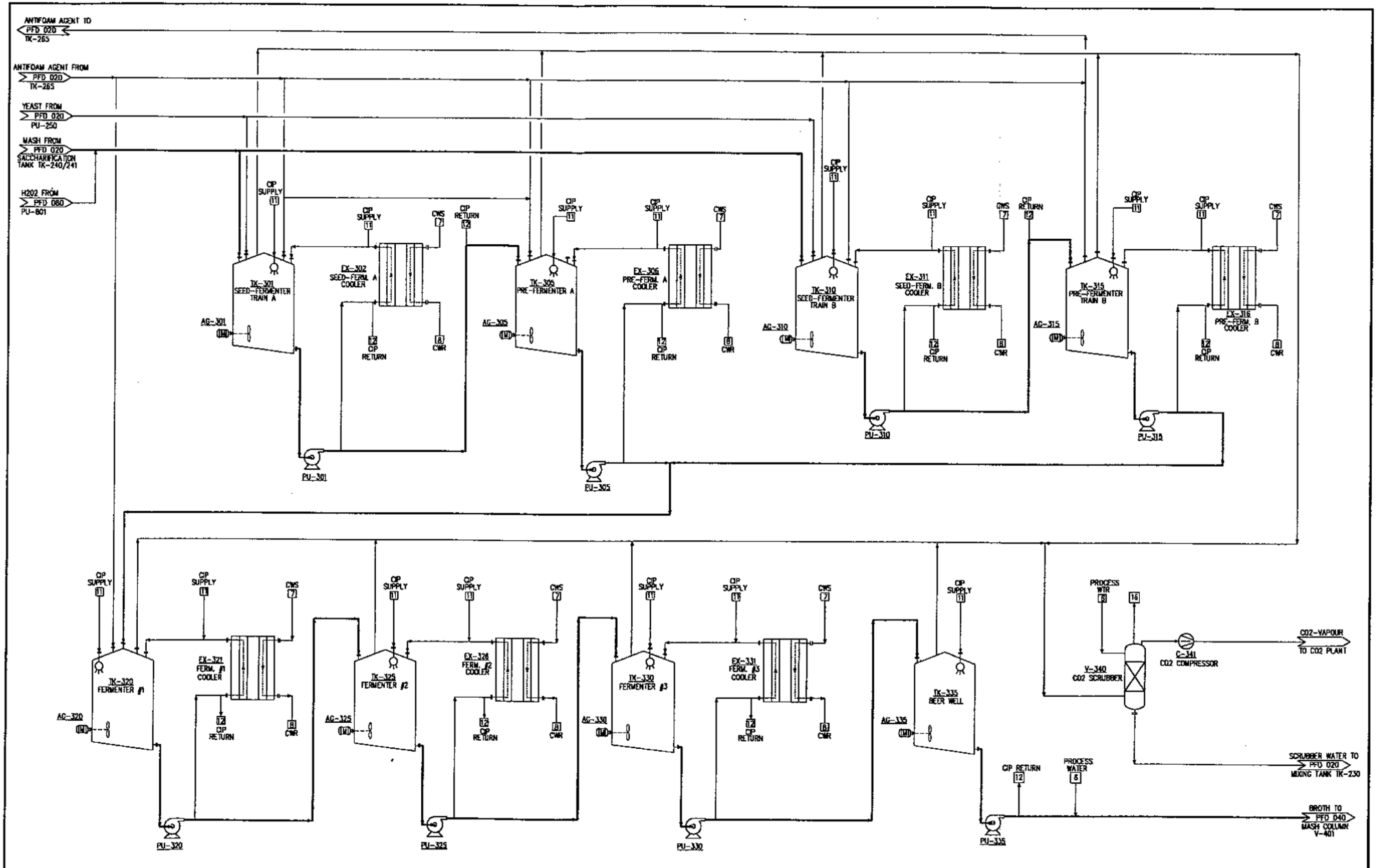
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
LIQUEFACTION & SACCHARIFICATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD020
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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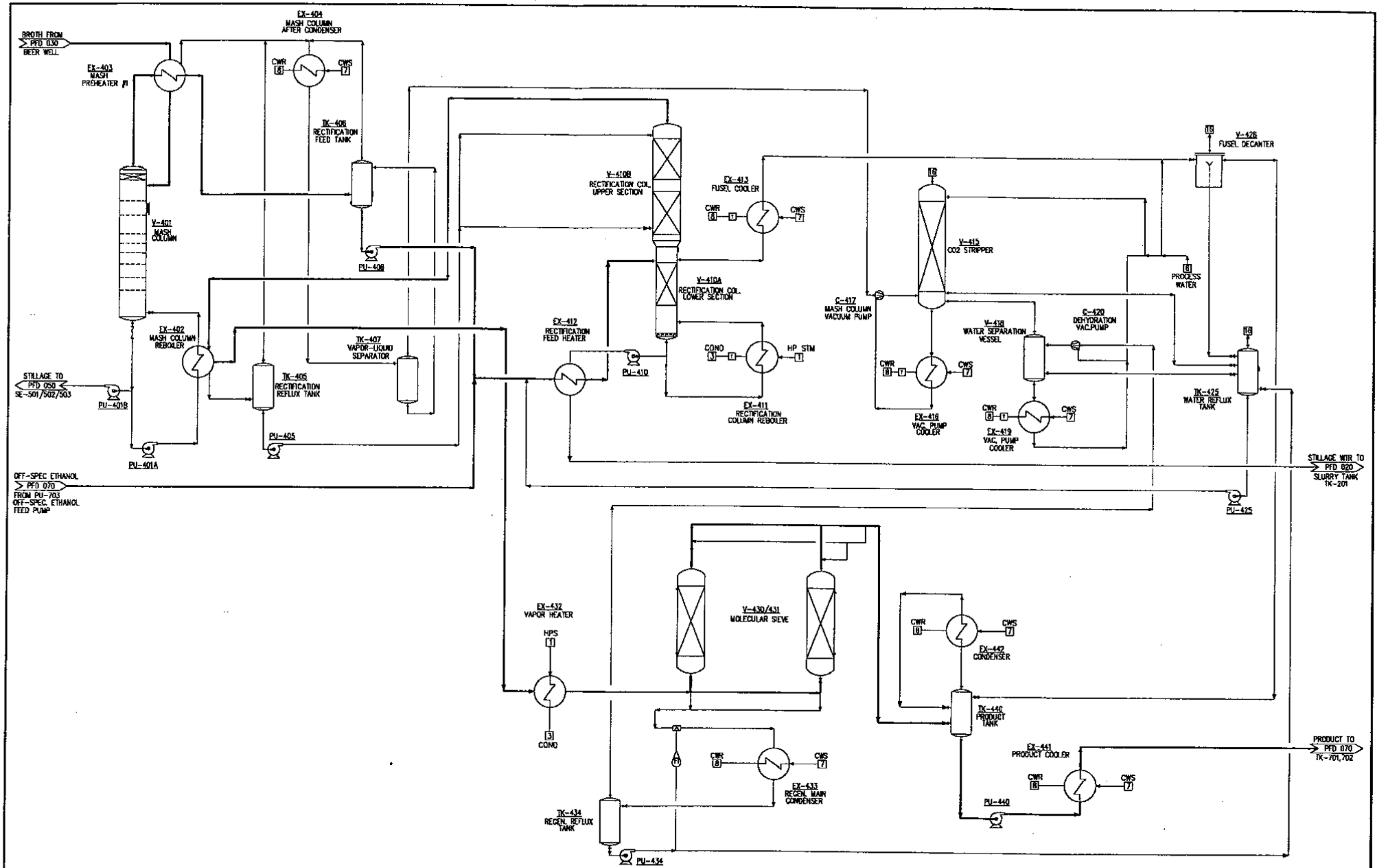
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
FERMENTATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD030
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

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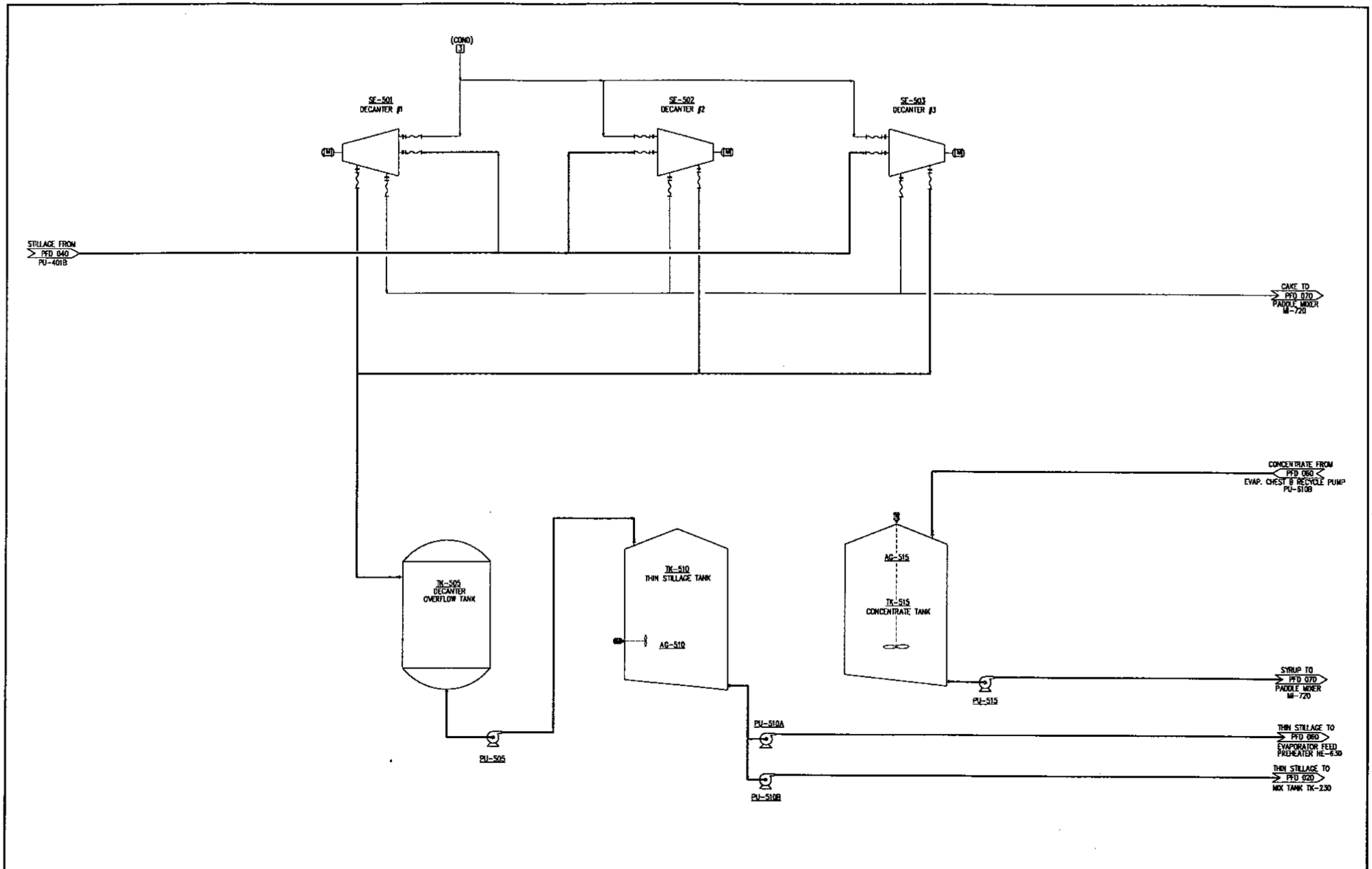
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
DISTILLATION

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD040
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 CP SUPPLY
12 CP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REOC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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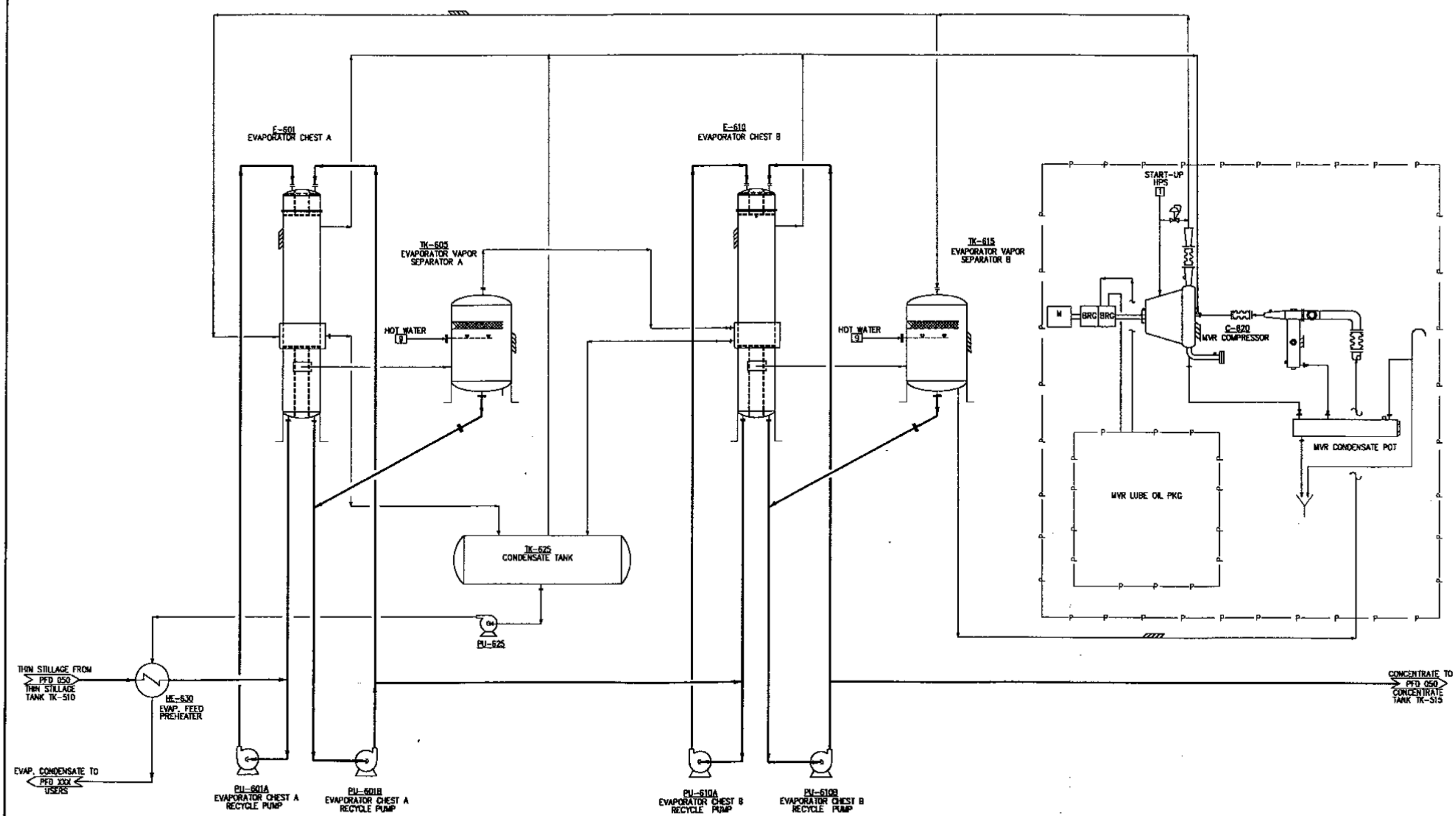
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
STILLAGE DECANTERS

PROJECT NUMBER: 78849.001
DRAWING NUMBER: PFD050
REVISION: A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM
2 LP STEAM
3 HP CONDENSATE
4 LP CONDENSATE
5 CITY WATER (POTABLE)
6 PROCESS WATER
7 COOLING TOWER WATER SUPPLY
8 COOLING TOWER WATER RETURN
9 HOT WATER SUPPLY
10 HOT WATER RETURN
11 OP SUPPLY
12 OP RETURN
13 PLANT AIR
14 STERILE AIR
15 WASTE
16 VENT
17 NATURAL GAS

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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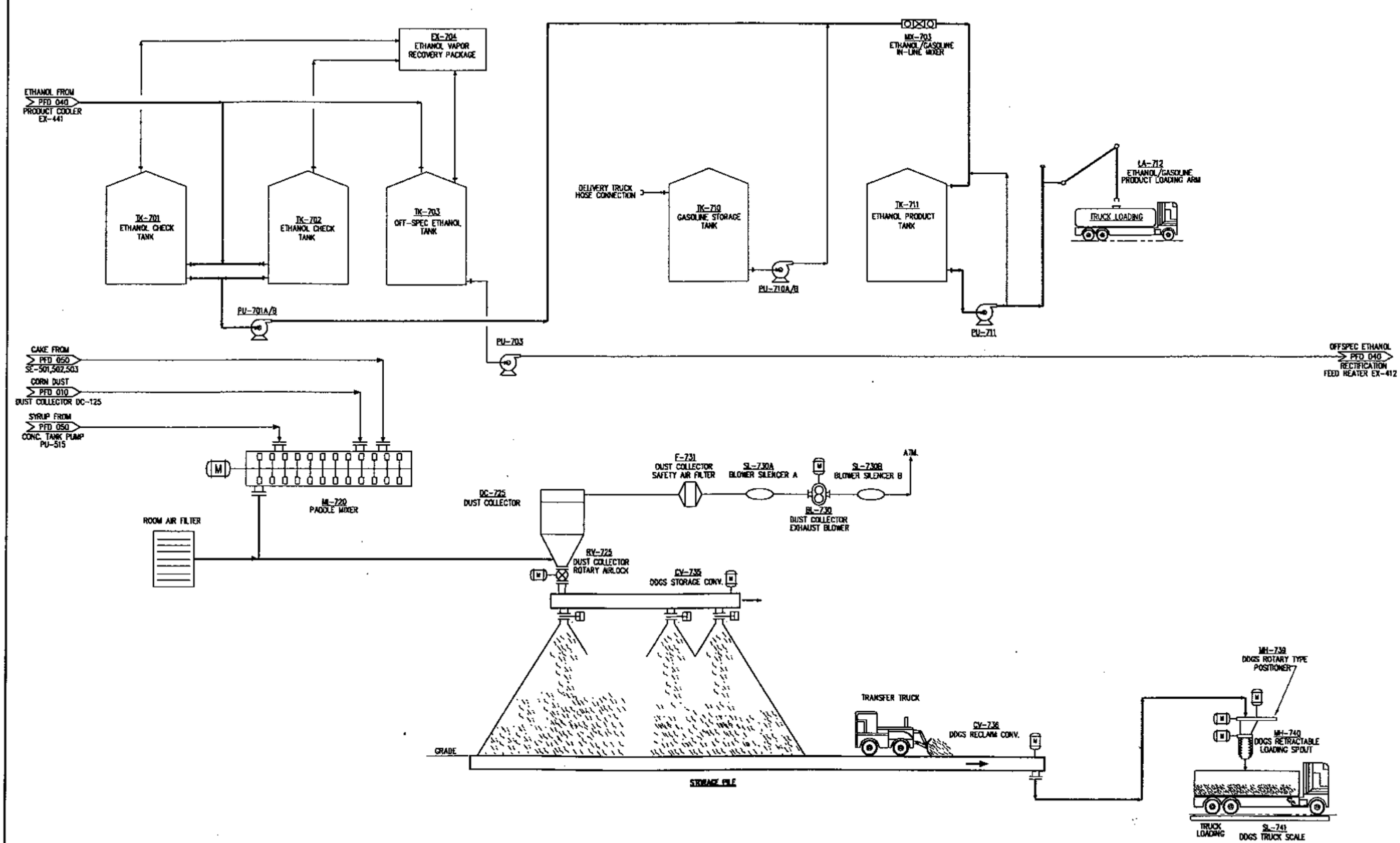
DOWNERS GROVE, ILLINOIS

DRAWN: RBP DATE: 05/10/98
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
EVAPORATION

PROJECT NUMBER: 78849.001
DRAWING NUMBER: PFD060
REVISION: A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CP SUPPLY
3 HP CONDENSATE	12 CP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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DOWNERS GROVE, ILLINOIS

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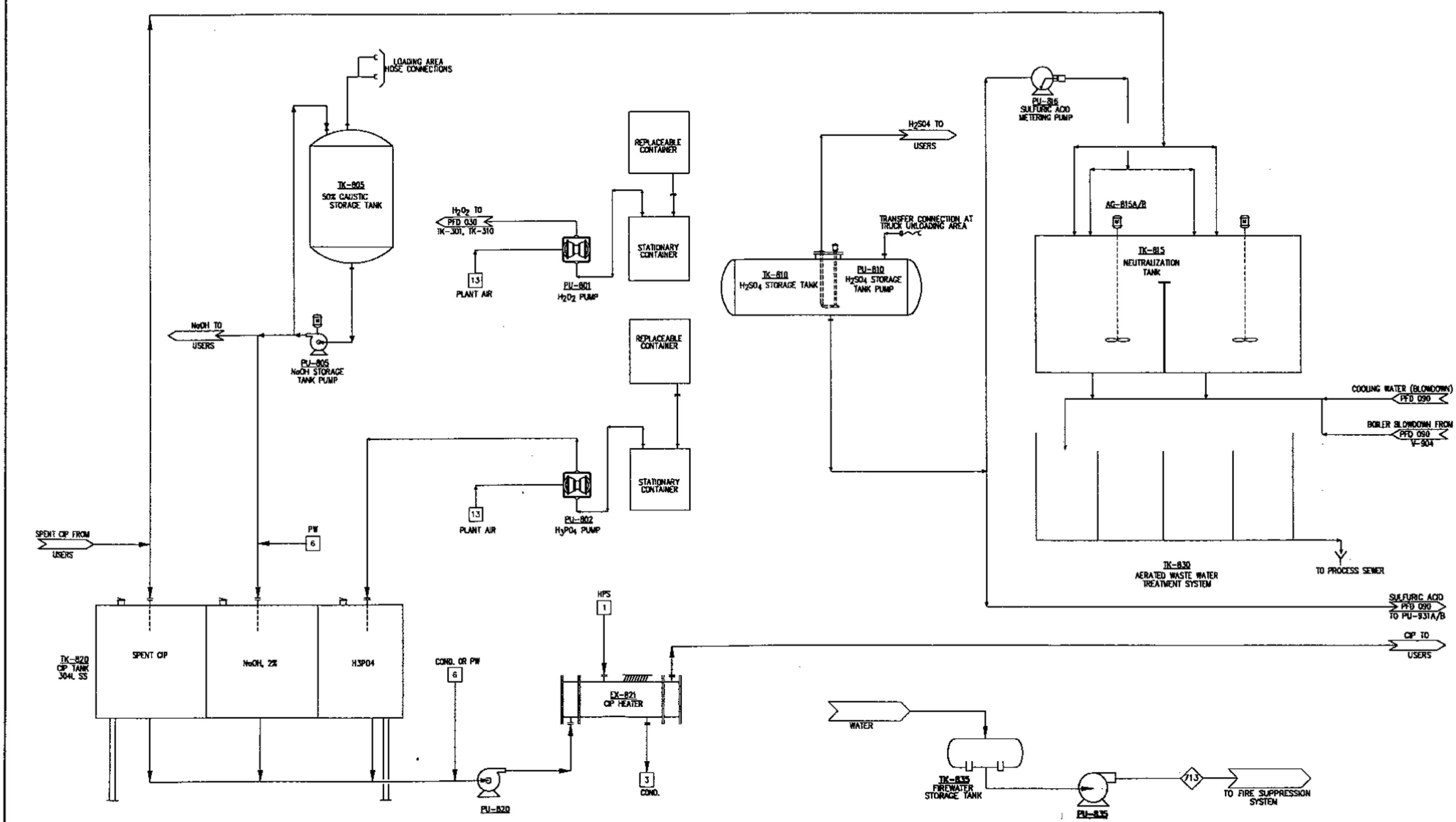
CHECKED: DATE:
REAC APPROVED: DATE:
CLIENT APPROVED: DATE:

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
PRODUCT STORAGE SYSTEM

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD070
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CIP SUPPLY
3 HP CONDENSATE	12 CIP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

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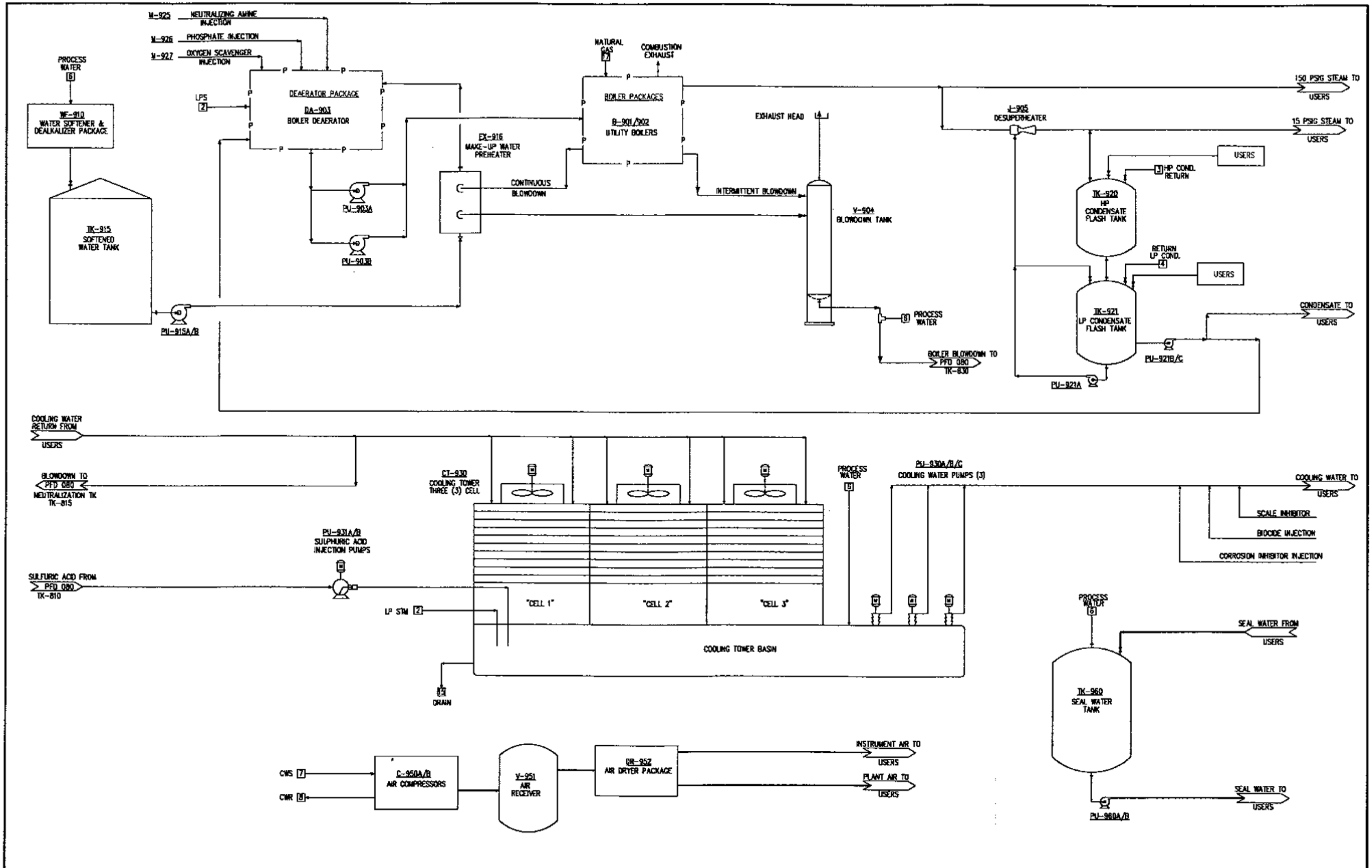
DOWNERS GROVE, ILLINOIS

DRAWN	DATE
RBP	05/10/99
CHECKED	DATE
REAC APPROVED	DATE
CLIENT APPROVED	DATE

NYSTEC

TITLE: PROCESS FLOW DIAGRAM
STORAGE TANKS, CIP
& NEUTRALIZATION SYSTEM

PROJECT NUMBER 78849.001
DRAWING NUMBER PFD080
REVISION A
SCALE: NONE



UTILITY LEGEND

1 HP STEAM	10 HOT WATER RETURN
2 LP STEAM	11 CP SUPPLY
3 HP CONDENSATE	12 CP RETURN
4 LP CONDENSATE	13 PLANT AIR
5 CITY WATER (POTABLE)	14 STERILE AIR
6 PROCESS WATER	15 WASTE
7 COOLING TOWER WATER SUPPLY	16 VENT
8 COOLING TOWER WATER RETURN	17 NATURAL GAS
9 HOT WATER SUPPLY	

REV. NO.	DATE	REVISION	BY	REAC APP'D	CLIENT APP'D
A		BASIS OF FACTOR ESTIMATES			

Raytheon Engineers & Constructors
DOWNERS GROVE, ILLINOIS

DRAWN RBP	DATE 05/10/99	NYSTEC		PROJECT NUMBER	78849.001
CHECKED	DATE			DRAWING NUMBER	PFD090
REAC APPROVED	DATE	TITLE:	UTILITY FLOW DIAGRAM UTILITY SYSTEM	REVISION	A
CLIENT APPROVED	DATE			SCALE:	NONE

Feedstock Production Quantities
1993-1998 Average Yield (tons)
Priority Listing

Feedstock Type	Priority	RCBS	North Country Region	New York State
Corn Stover	1A	1,339	49,720	1,208,000
Grass	1B	750	354,740	1,848,000
Straw	1C	212	2,978	294,740
Papermill Residue	1D	0	151,000	643,000
Corn	1E	1,962	69,185	1,859,200
Corn Silage	2	1,246	1,202,420	7,779,200
Cheese Whey	4	0	74,179	219,853
Brewery Solids	3	0	0	2,901,690
Vegetable Wastes				
Beets	7	0	0	17,045
Cabbage	6	0	0	19,240
Carrots	11	0	0	8,218
Peas	12	0	0	3,767
Snap Beans	8	0	0	14,281
Sweet Corn	5	0	0	149,856
Fruit Pomace				
Apples	10	0	0	46,132
Cherries	14	0	0	1283
Grapes	9	0	0	77,195
Winery Waste	13	0	0	18,853
Willow Biomass	15	0	0	230

The quantity for all the vegetable feed stocks may need to be adjusted for quality. Having some experience at a particular vegetable-handling factory that produced frozen vegetables for packaging, the amount of sweet corn waste needs to be categorized. I have seen culls for grease contamination before processing, which I suspect occurs at these facilities also. These culls cannot be used in the ethanol plant because of the grease contamination that would occur. I believe that the "clean" shuckings and cobs are processable.

June 3, 1999

Ms. Anne Hartman
NYSTEC
75 Electronic Parkway, Suite 2
Rome, NY 13441-4505

Subject: Feedstock Analysis
Project No. 78849.001

Dear Ms. Hartman:

The feedstock analysis sheets have been studied and considered for incorporation into an alcohol plant(s). Attached are summary analysis sheets for potential State Wide, North Country, and Ron Robbins farm alcohol production. Current analysis suggests:

- Ron Robbins farm is not a large enough raw material supplier for its own plant
- The North Country (as currently defined) may be a large enough raw material supplier for a plant. It could be made more viable by including several other counties.
- Corn stover, grass, straw, and corn appear to be very viable feedstocks, probably for up to 4 plants of 50-60 million gallons.

A discussion about all feedstocks follows:

Corn Stover, Grass, Straw

The corn stover, grass and straw will be discussed as one group since they can be handled similarly for plant feed stock. They require a minimum double size reduction for input to the process. These materials were initially considered as baled units for input to the plant. However, material handling analysis suggests that the best way to bring these materials to the plant are in a pulverized bulk state of 2 to 4 inch pieces, or smaller. This makes it easier to handle and surge. The pulverized bulk state of 2 to 4 inch pieces would be further reduced at the plant to less than ¾ inch size for surge storage and process input. The surge storage would consist of a flat slab and reclaimer with weather protection. The basis of the 2 to 4 inch pieces are pulverizing using a tub grinder, or feed cutter, probably already in use on the farm to process bales, at the farm to fill standard semi-trailers for delivery to the plant.

Corn

Corn is the easiest material to handle because of current commercialization. However, the production volume seemed high. The corn rate was adjusted to the surplus grain quantity produced in 1997 according to New York Agricultural Statistics. The rate was then increased by 15% assuming that the DDGS produced would replace an equal amount of corn currently used in animal feed. The plan sizing basis was increased an additional 25% to 30MM gallons of ethanol per year to allow for some immediate growth in corn supply and for equipment optimizations.

Corn Silage

Corn silage was not considered. It is probably only grown for dairy cow feed and supplies the demand. Storage and handling characteristics favor dry bulk solids. This also increases the wastewater handling requirements because of the water content.

Sweet Corn

Utilization of sweet corn residue increases the wastewater flow rate an estimated 50% for a short period (assumed 3 months). A possible fee to support the increase size of the waste treatment plant has poor economics for the amount of utilization. Additionally, the waste treatment plant would be very hard to operate for 9 months of the year with that much extra capacity.

Brewery Solids

The availability of brewery solids is suspect. They probably already dispose of the solids in an efficient economical method. However, if they do not, they should be able to support their own plant for the potential quantity of alcohol.

Papermill Residue

The papermill residue needs additional information to determine whether it is attractive or sufficiently available for feedstock. The data sheet denotes 263,000 tons per year of the 643,000 tons per year produced being taken by the industrial stoker coal market. This portion of the materials may be the lower ash content portions, which are the same desirable materials for the ethanol plant. The high ash deinking mill stock is not desirable because of higher ion exchange and overliming capacity requirements, and higher fouling rates for the boiler burning the waste solids. Quantities of bark and woodchips would be desirable.

Other Feedstocks

The other feedstocks; cabbage, beets, beans, grapes, apples, carrots, peas, wine waste, and cherries, are not attractive for the relatively small amounts of alcohol produced and the large amounts of wastewater. Apples have an additional problem because of the pectin content (a thickening agent). This would increase the pump motor horsepowers. The fruits; grapes, apples, and cherries, also would probably need to be pasteurized to reduce the formation of acetic acid from fermentation before loading into a truck for transportation to the plant. Higher acetic acid content would increase the ion exchange and overliming system sizes. These unattractive feedstocks could become attractive with an appropriate fee structure.

We are proceeding on the basis of a plant based on corn stover, grass, and straw, as well as a plant based on corn grain.

Sincerely,

James E. Cole
Project Manager

cc: Gail Luttinen

NYSTEC
PROJECT NO. 78849.001
TRIP REPORT NO. 1

TRIP DATE: March 10, 1999

DATE: May 4, 1999

LOCATION: Ron Robbins Farm - Kitchen

Attendees:	RE&C	NYCGA	NYSTEC	PIONEER
	J. Cole G. Luttinen S. Newberg	Jim Czub Ron Robbins	Anne Hartman	Keith Culver

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There was general discussion about the project and opportunities. The NYCG Association has a 5 year goal to develop an alcohol plant or some other additional opportunity to expand economic horizon for farm products. An alcohol plant may be in the range of 15MM gal/year.

Corn grain crop production is now 108% of farmers needs for dairy and live stock feeds. Hay and straw are now baled in 3x3x8 foot bales, which can contain small quantities of small stones.

Robbins Corn & Bulk Services grain processing facility is located on South Harbor road (a county highway) Sacketts Harbor, NY. The following observations were made

- Nearest natural gas service – 1.8 miles west on South Harbor Road at small store.
- Nearest 3 phase electrical – 0.7 miles for farm power service.
- Nearest community water service – 1.5 miles to small water tower and main.
- Well water at 50 to 250 feet.
- 2 miles to Lake Ontario
- Topsoil generally 1 to 4.5 feet thick over limestone bedrock.
- Major power substations:
  - North Watertown – 10 miles as crow flies
  - Adams – 7 miles as crow flies
- Rail service by Conrail about 7 miles in Adams at Agway, runs north-south.
- No barge facilities remain in Socketts Harbor
- Wes Alcombrak zoning official, 315-788-2777
- Niagara Mohawk Electric Power Company

Wet DDGS has a useful "shelf-life" of 5 to 20 days for animal feed according to Ron Robbins experience. DDGS has previously been obtained in 25-ton loads.

Post meeting follow-up: there is a potential for 200,000 t/yr of DDGS usage by the dairy industry.

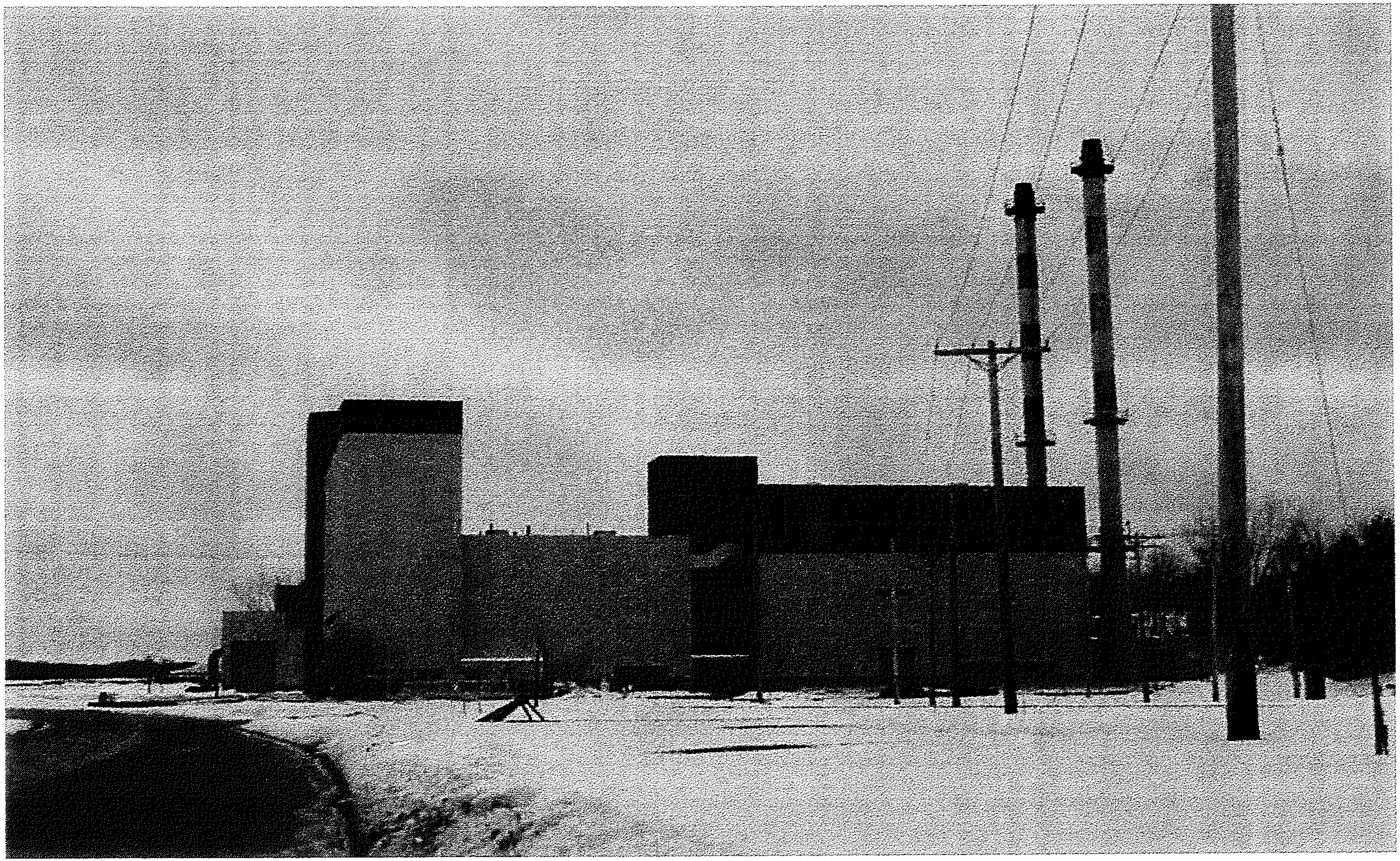
Jim Czub
NCGA Corn Board Liaison NY
141 Verbeck Ave.
Schaghticoke, NY 12154
518-753-7795 (P)
518-753-0059 (F)

Ron Robbins
President NYCGA
14471 County Rt. 145
Sackets Harbor, NY 13685
315-583-5016 (P)
315-583-6483 (F)

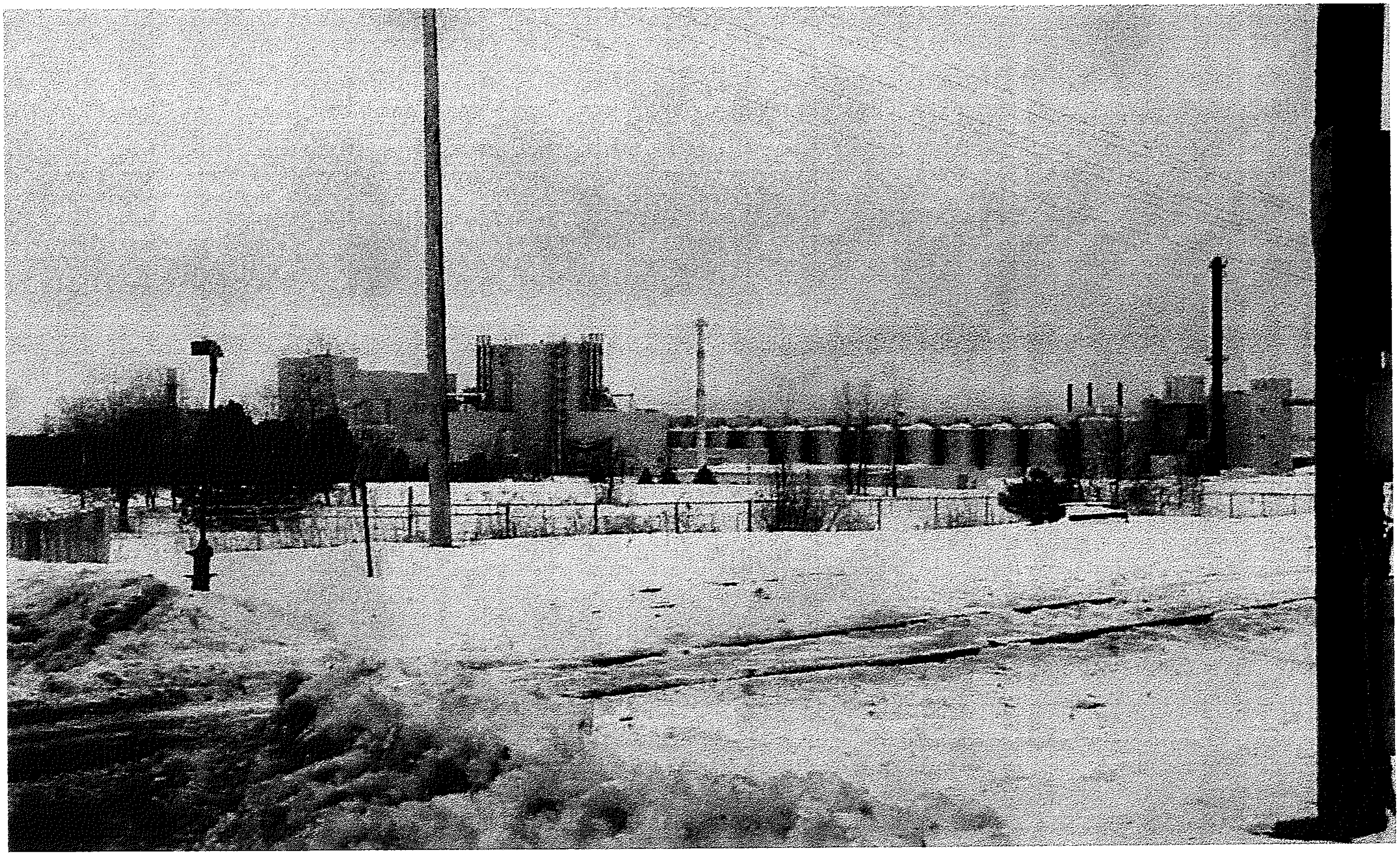
Keith Culver
RD #1 Box 184
Auburn, NY 13021
315-364-6750 (P)
315-252-6100 (F)

ROBBINS CORN AND BULK SERVICE

GRIFFISS AFB BOILER

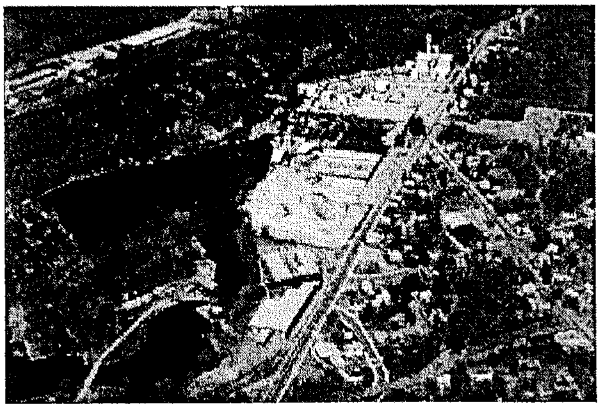


MILLER BREWERY
FULTON, NEW YORK



MILLER BREWERY
FULTON, NEW YORK

Carthage Paper Mill Site



Village of Carthage, Jefferson County, New York

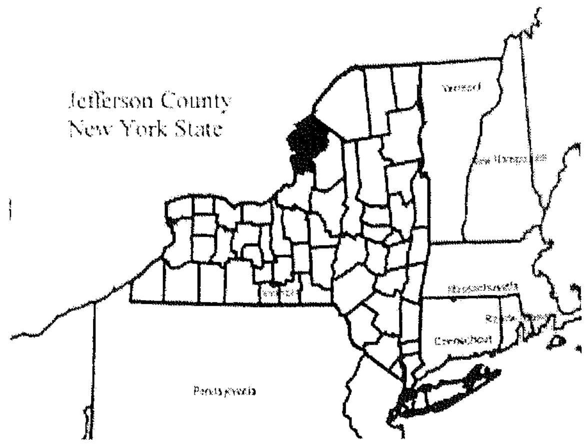
Links to Information on Jefferson County

Northern New York Regional Profile

County Job Development Corporation

Jefferson County Industrial Development Agency

Greater Watertown Chamber of Commerce



Site Features (Click here to view full page photo)

- **66 Acres Available (22 seperate buildings)**
- **Industrial Zoning**
- **Buildings contain a total of 224,000 sq. ft. of production and warehouse space**
- **Electric provided by Niagara Mohawk** http://www.nimo.com
- **Natural gas supplied by Niagara Mohawk** http://www.nimo.com
- **Water provided by the City of Watertown**
- **Wastewater treatment services provided by the City of Watertown**

Note: This facility was used as a paper producing and converting mill less than 1 year ago. The site will soon be controlled by the Jefferson County Industrial Development Agency and will be available at terms well below market rates.

Return to Home Additional Information Find Another Site Find Another Building

Contact Us At:

Niagara Mohawk
Economic & Community Development
300 Erie Boulevard West
Syracuse, NY 13202
800-944-6460
email at carthage@shovelready.com

Niagara Mohawk Power for UPSTATE NEW YORK

NYSTEC

Appendix D

Baseline Pro-Forma

Capital and Site Review

	Cost At Startup
Improvements to Site	$1,264,000
Earthwork	$4,108,000
Concrete	$10,113,000
Structural Steel	$6,687,000
Process Equipment	$63,206,000
Piping	$29,075,000
Insulation	$3,792,000
Instrumentation & Controls	$18,962,000
Electrical	$10,745,000
Painting	$1,896,000
Building & Architectural	$9,481,000
Direct Field Cost	$159,329,000
Start-up, Testing & Training	Excluded
Temporary Facilities	Included Above
Construction Equipment, Tools, Supplies	Included Above
Field Staff and Legalities	$4,677,000
Indirect Field Cost	$4,677,000
Total Field Cost	$164,006,000
Engineering	$13,906,000
Total Field and Home Office	$177,912,000
Taxes	$0
Insurance	$1,011,296
Permits	$94,809
Craft Causal Overtime	$506,000
Contingency	$46,140,000
Escalation	$0
Substotal	$225,664,105
CM Fee	$4,680,000
Total	$230,344,105

Debt Schedule

Long-term debt

A	Amortize
Term (Years):	15
Cost of Capital and Site Work:	$230,344,105
Up-Front Payment:	$0
Working Capital:	$23,034,411
Original Balance:	$253,378,516
Balloon Pmt:	$0
Debt / Equity Ratio:	n/a

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Debt Balance:	$90,595,955	$140,370,873	$253,378,516	$246,014,008	$237,839,405	$228,765,596	$218,693,667	$207,513,827	$195,104,204	$181,329,522	$166,039,626	$149,067,841	$130,229,159	$109,318,223	$86,107,083	$60,342,719	$31,744,274	$0	$0	$0	$0	$0
Interest Rate above inflation(%):	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%
Interest Pmt:	$9,965,555	$15,440,796	$27,871,637	$27,061,541	$26,162,335	$25,164,218	$24,056,303	$22,826,521	$21,461,462	$19,946,247	$18,264,359	$16,397,462	$14,325,208	$12,025,005	$9,471,779	$6,637,699	$3,491,870	$0	$0	$0	$0	$0
Principal Pmt:	($9,965,555)	$0	$7,364,507	$8,174,603	$9,073,809	$10,071,928	$11,179,841	$12,409,623	$13,774,682	$15,289,896	$16,971,785	$18,838,681	$20,910,936	$23,211,139	$25,764,365	$28,598,445	$31,744,274	($0)	($0)	($0)	($0)	($0)
Additional Principal Pmt:																						
Sub-Total Payment:	$0	$15,440,796	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$0	$0	$0	$0	$0
Amortization of Loan Fees:	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$0	$0	$0	$0	$0	$0	$0
Total Payment:	$236,487	$15,677,283	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,472,631	$35,236,144	$35,236,144	$0	$0	$0	$0	$0
	into depr. Exp.																					

Long-term debt Summary

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Opening Balance:	$90,596,956	$140,370,873	$253,378,516	$246,014,008	$237,839,405	$228,765,596	$218,693,667	$207,513,827	$195,104,204	$181,329,522	$166,039,626	$149,067,841	$130,229,159	$109,318,223	$86,107,083	$60,342,719	$31,744,274	$0	$0	$0	$0	$0
Total Interest Pmts:	$9,965,555	$15,440,796	$27,871,637	$27,061,541	$26,162,335	$25,164,218	$24,056,303	$22,826,521	$21,461,462	$19,946,247	$18,264,359	$16,397,462	$14,325,208	$12,025,005	$9,471,779	$6,637,699	$3,491,870	$0	$0	$0	$0	$0
Total Principal Pmts:	-$9,965,555	$0	$7,364,507	$8,174,603	$9,073,809	$10,071,928	$11,179,841	$12,409,623	$13,774,682	$15,289,896	$16,971,785	$18,838,681	$20,910,936	$23,211,139	$25,764,365	$28,598,445	$31,744,274	($0)	($0)	($0)	($0)	($0)
Additional Principal Pmts:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Payments:	$0	$15,440,796	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$0	$0	$0	$0	$0
Closing Balance:	$100,561,510	$140,370,873	$246,014,008	$237,839,405	$228,765,596	$218,693,667	$207,513,827	$195,104,204	$181,329,522	$166,039,626	$149,067,841	$130,229,159	$109,318,223	$86,107,083	$60,342,719	$31,744,274	$0	$0	$0	$0	$0	$0
Avg Annualized Rate Pd.:	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%	11.00%

Effect of Depreciation

Total Value of Depreciation: $240,309,660

Depreciation based on: 20 year straightline method

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
t and Equipment Value at start of year	$100,561,510	$140,370,873	$228,294,177	$216,278,694	$204,263,211	$192,247,728	$180,232,245	$168,216,762	$156,201,279	$144,185,796	$132,170,313	$120,154,830	$108,139,347	$96,123,864	$84,108,381	$72,092,898	$60,077,415	$48,061,932	$36,046,449	$24,030,966	$12,015,483	$0
Less Accumulated Depreciation:	$0	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$0
Plant and Equipment Value After Year:	$100,561,510	$128,355,390	$216,278,694	$204,263,211	$192,247,728	$180,232,245	$168,216,762	$156,201,279	$144,185,796	$132,170,313	$120,154,830	$108,139,347	$96,123,864	$84,108,381	$72,092,898	$60,077,415	$48,061,932	$36,046,449	$24,030,966	$12,015,483	$0	$0

Start-up Expenses

Years to Pay-off: 5

Cost of Startup: $6,919,818

Interest Rate (above Inflation) used: 0.00%

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Debt Balance:	$0	$6,919,818	$5,535,854	$4,151,891	$2,767,927	$1,383,964	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Interest Rate above inflation(%):	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Interest Pmt:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Principal Pmt:	$0	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Principal Pmt:																						
Sub-Total Payment:	$0	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Amortization of Loan Fees:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Payment:	$0	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Conversion to Baseline Year Dollars

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Discount Factor:	1.00	1.00	1.00	0.97	0.94	0.92	0.89	0.86	0.84	0.81	0.79	0.77	0.74	0.72	0.70	0.68	0.66	0.64	0.62	0.61	0.59	0.57
Depreciation in Current Year Dollars:	$0	$12,015,483	$12,015,483	$11,665,517	$11,325,745	$10,995,869	$10,675,601	$10,364,661	$10,062,778	$9,769,687	$9,485,133	$9,208,867	$8,940,648	$8,680,241	$8,427,418	$8,181,959	$7,943,650	$7,712,281	$7,487,652	$7,269,565	$7,057,830	$0
Interest Payment in Current Year Dollars:	$9,965,555	$15,440,796	$27,871,637	$26,273,341	$24,660,510	$23,028,822	$21,373,714	$19,690,357	$17,973,637	$16,218,124	$14,418,054	$12,567,290	$10,659,300	$8,687,119	$6,643,315	$4,519,950	$2,308,538	$0	$0	$0	$0	$0
Amortization of Loan Fees:	$236,487	$236,487	$236,487	$229,599	$222,912	$216,419	$210,116	$203,996	$198,054	$192,286	$186,685	$181,248	$175,969	$170,843	$165,867	$0	$0	$0	$0	$0	$0	$0
Principle in Current Dollars:	-$9,965,555	$0	$7,364,507	$7,936,508	$8,552,936	$9,217,241	$9,933,144	$10,704,650	$11,536,079	$12,432,086	$13,397,684	$14,438,281	$15,559,701	$16,768,221	$18,070,607	$19,474,149	$20,988,705	$0	$0	$0	$0	$0
Total Loan Payment in Current Year Dollars:	$236,487	$16,677,283	$35,472,631	$34,439,448	$33,436,357	$32,462,482	$31,516,973	$30,599,003	$29,707,770	$28,842,495	$28,002,422	$27,186,818	$26,394,969	$25,626,183	$24,879,790	$23,994,099	$23,296,242	$0	$0	$0	$0	$0
Start-up Expenses in Actual Year Dollars:	$0	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$1,383,964	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Start-up Expenses in Baseline Year Dollars:	$0	$1,383,964	$1,383,964	$1,343,654	$1,304,518	$1,266,523	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Annual Materials Costs

	Amount	Unit	Cost	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Feedstock																									
Biomass	840,000	tons/year	$35.00	$0	$14,700,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000
Operating Chemicals																									
H2SO4	4,170	pounds/hr	$0.03	$0	$455,364	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728	$910,728
Lime	1,764	pounds/hr	$0.04	$0	$277,830	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660	$555,660
NH3	1,530	pounds/hr	$0.11	$0	$674,730	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460	$1,349,460
CSL	2	tons/hr	$25.00	$0	$217,455	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910	$434,910
Nutrients	383	pounds/hr	$0.12	$0	$199,466	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933	$398,933
NH4SO4	863	pounds/hr	$0.02	$0	$81,554	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107	$163,107
Antifoam	12	pounds/hr	$0.24	$0	$12,096	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192	$24,192
Gasoline	369	gal/hr	$0.60	$0	$929,880	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760	$1,859,760
BFW Chemicals	2	pounds/hr	$0.97	$0	$8,963	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926	$17,926
CW Chemicals	11	pounds/hr	$1.00	$0	$46,200	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400	$92,400
WWT Nutrients	495	pounds/hr	$0.11	$0	$228,690	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380	$457,380
WWT Chemicals	2	pounds/hr	$2.50	$0	$17,116	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230	$34,230
NAOH	110	pounds/hr	$0.17	$0	$76,230	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460	$152,460
H3PO4	22	pounds/hr	$0.37	$0	$34,188	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376	$68,376
H2O2	44	pounds/hr	$0.50	$0	$91,476	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952	$182,952
Cellobiase	750	pounds/yr	$150.00	$0	$56,250	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500
Cellulase	750	pounds/yr	$150.00	$0	$56,250	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500	$112,500
Process Water																									
Water				$0	$723,198	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396
Natural Gas																									
Natural Gas	100	therms/hr	$1.86	$0	$781,200	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400
Disposal Costs																									
Landfill	3,735	pounds/hr	$0.01	$0	$156,870	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740
Maintenance Materials																									
Maintenance Materials				$0	$983,100	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200	$1,966,200
Lubricants				$0	$5,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
Laboratory Chemicals				$0	$48,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000	$96,000
Miscellaneous Incedentals																									
Operating Supplies				$0	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000
Total Cost				$0	$21,306,106	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209	$42,167,209

Employee Forecast

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Production								
Number of Employees:	0	42.7	97	97	97	97	97	97
Avg. Salary/Wage per Employee:	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Employer Contribution ($):	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524
Per Employee Total:	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627
Production Salary/Wage Total:	$0	$2,138,400	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000
Employer Contribution Total:	$0	$491,832	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800
Department Total:	$0	$2,630,232	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800
General & Administrative								
Number of Employees:	0	3.1	7	7	7	7	7	7
Avg. Salary/Wage per Employee:	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Employer Contribution ($):	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950
Per Employee Total:	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950
General & Administrative Salary/Wage Total:	$0	$200,200	$455,000	$455,000	$455,000	$455,000	$455,000	$455,000
Employer Contribution Total:	$0	$46,046	$104,650	$104,650	$104,650	$104,650	$104,650	$104,650
Department Total:	$0	$246,246	$559,650	$559,650	$559,650	$559,650	$559,650	$559,650
Total Number of Employees:	0	46	104	104	104	104	104	104
Avg. Salary/Wage per Employee:	$0	$51,106	$51,106	$51,106	$51,106	$51,106	$51,106	$51,106
Avg. per Employee Contribution (%):	0.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Avg. per Employee Contribution ($):	$0	$11,754	$11,754	$11,754	$11,754	$11,754	$11,754	$11,754
Total Salary/Wage Expense:	$0	$2,338,600	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000
Total Employer Contribution (%):	0.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Total Employer Contribution ($):	$0	$537,878	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450
Total Employee Expense:	**$0**	**$2,876,478**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**

	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Production							
Number of Employees:	97	97	97	97	97	97	97
Avg. Salary/Wage per Employee:	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Employer Contribution ($):	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524
Per Employee Total:	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627
Production Salary/Wage Total:	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000
Employer Contribution Total:	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800
Department Total:	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800
General & Administrative							
Number of Employees:	7	7	7	7	7	7	7
Avg. Salary/Wage per Employee:	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Employer Contribution ($):	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950
Per Employee Total:	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950
General & Administrative Salary/Wage Total:	$455,000	$455,000	$455,000	$455,000	$455,000	$455,000	$455,000
Employer Contribution Total:	$104,650	$104,650	$104,650	$104,650	$104,650	$104,650	$104,650
Department Total:	$559,650	$559,650	$559,650	$559,650	$559,650	$559,650	$559,650
Total Number of Employees:	104	104	104	104	104	104	104
Avg. Salary/Wage per Employee:	$51,106	$51,106	$51,106	$51,106	$51,106	$51,106	$51,106
Avg. per Employee Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Avg. per Employee Contribution ($):	$11,754	$11,754	$11,754	$11,754	$11,754	$11,754	$11,754
Total Salary/Wage Expense:	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000
Total Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Total Employer Contribution ($):	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450
Total Employee Expense:	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Production							
Number of Employees:	97	97	97	97	97	97	97
Avg. Salary/Wage per Employee:	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103	$50,103
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Employer Contribution ($):	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524	$11,524
Per Employee Total:	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627	$61,627
Production Salary/Wage Total:	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000	$4,860,000
Employer Contribution Total:	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800	$1,117,800
Department Total:	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800	$5,977,800
General & Administrative							
Number of Employees:	7	7	7	7	7	7	7
Avg. Salary/Wage per Employee:	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000	$65,000
Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Employer Contribution ($):	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950	$14,950
Per Employee Total:	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950	$79,950
General & Administrative Salary/Wage Total:	$455,000	$455,000	$455,000	$455,000	$455,000	$455,000	$455,000
Employer Contribution Total:	$104,650	$104,650	$104,650	$104,650	$104,650	$104,650	$104,650
Department Total:	$559,650	$559,650	$559,650	$559,650	$559,650	$559,650	$559,650
Total Number of Employees:	104	104	104	104	104	104	104
Avg. Salary/Wage per Employee:	$51,106	$51,106	$51,106	$51,106	$51,106	$51,106	$51,106
Avg. per Employee Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Avg. per Employee Contribution ($):	$11,754	$11,754	$11,754	$11,754	$11,754	$11,754	$11,754
Total Salary/Wage Expense:	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000	$5,315,000
Total Employer Contribution (%):	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%	23.00%
Total Employer Contribution ($):	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450	$1,222,450
Total Employee Expense:	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**	**$6,537,450**

Revenue Forecast

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Alcohol	$0	$28,635,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000
Electricity	$0	$1,577,833	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008
CO2 Sales	$0	$360,540	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770
DDGS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Gross Revenues	$0	$30,573,373	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Returns/Allowances (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Adjusted Revenues	$0	$30,573,373	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Alcohol cost after producer credit	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Alcohol	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000	$69,000,000
Electricity	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008	$3,802,008
CO2 Sales	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770	$868,770
DDGS	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Gross Revenues	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Returns/Allowances (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Adjusted Revenues	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Alcohol cost after producer credit	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150	$1.150

Tax Impacts

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Taxable Income	(236,487)	(25,219,724)	(19,075,236)	(17,079,777)	(15,081,351)	(13,075,299)	(9,827,097)	(7,826,681)	(5,802,135)	(3,747,763)	(1,657,538)	474,930	2,656,418	4,894,131	7,195,733	9,730,425	12,180,147	14,720,053	14,944,682	15,162,769	15,374,504	22,432,334
Cumulative taxable	(236,487)	(25,456,211)	(44,531,448)	(61,611,225)	(76,692,576)	(89,767,875)	(99,594,971)	(107,421,652)	(113,223,787)	(116,971,550)	(118,629,088)	(118,154,159)	(115,497,741)	(110,603,610)	(103,407,876)	(93,677,452)	(81,497,305)	(66,777,253)	(51,832,570)	(36,669,801)	(21,295,297)	1,137,037
Federal Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$397,963
State Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sales Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Property Taxes	$0	$0	$0	$0	$0	$0	$0	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000
Incentives	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Tax Burden	$0	$0	$0	$0	$0	$0	$0	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$406,963
Jobs Created	0	46	104	104	104	104	104	104	104	104	104	104	104	104	104	104	104	104	104	104	104	104
Mulitplier Jobs	0	55	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125	125
On Farm Jobs	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
State/Local Job Impact	$0	$3,440	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819
Total Impact Value	$0	$346,356	$1,789,029	$1,789,029	$1,789,029	$1,789,029	$1,789,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$1,798,029	$2,195,992

Income Statement

Income / Expenses in Baseline Year Dollars

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Total Income											
Sales of Ethanol and Co-Products	$0	$30,573,373	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Total	$0	$30,573,373	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Total Expenses											
Feedstock	$0	$14,700,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000
Operating Chemicals	$0	$3,463,737	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473
Process Water	$0	$723,198	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396
Natural Gas	$0	$781,200	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400
Disposal Costs	$0	$156,870	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740
Maintenance Materials	$0	$1,036,100	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200
Miscellaneous Incidentals	$0	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000
Salaries / Wages	$0	$2,876,478	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450
Depreciation	$0	$12,015,483	$12,015,483	$11,665,517	$11,325,745	$10,995,869	$10,675,601	$10,364,661	$10,062,778	$9,769,687	$9,485,133
Interest Expense	$0	$15,440,796	$27,871,637	$26,273,341	$24,660,510	$23,028,822	$21,373,714	$19,690,357	$17,973,637	$16,218,124	$14,418,054
Amortization of Loan Fees	$236,487	$236,487	$236,487	$229,599	$222,912	$216,419	$210,116	$203,996	$198,054	$192,286	$186,685
Insurance	$0	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785
Amortization of Start-up Expenses	$0	$1,383,984	$1,383,984	$1,343,654	$1,304,518	$1,266,523	$0	$0	$0	$0	$0
Total	$236,487	$55,793,097	$92,746,014	$90,750,555	$88,752,129	$86,746,077	$83,497,875	$81,497,459	$79,472,913	$77,418,541	$75,328,316
Pre-Tax Profit	($236,487)	($25,219,724)	($19,075,236)	($17,079,777)	($15,081,351)	($13,075,299)	($9,827,097)	($7,826,681)	($5,802,135)	($3,747,763)	($1,657,538)
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
State Tax, Sales Tax, Property Tax	$0	$0	$0	$0	$0	$0	$0	$9,000	$9,000	$9,000	$9,000
Profit After Taxes	($236,487)	($25,219,724)	($19,075,236)	($17,079,777)	($15,081,351)	($13,075,299)	($9,827,097)	($7,836,681)	($5,811,135)	($3,756,763)	($1,666,538)

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Total Income											
Sales of Ethanol and Co-Products	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Total	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778	$73,670,778
Total Expenses											
Feedstock	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000	$29,400,000
Operating Chemicals	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473	$6,927,473
Process Water	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396	$1,446,396
Natural Gas	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400	$1,562,400
Disposal Costs	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740	$313,740
Maintenance Materials	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200	$2,072,200
Miscellaneous Incidentals	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000	$445,000
Salaries / Wages	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450	$6,537,450
Depreciation	$9,208,867	$8,940,648	$8,680,241	$8,427,418	$8,181,959	$7,943,650	$7,712,281	$7,487,652	$7,269,565	$7,057,830	$0
Interest Expense	$12,567,290	$10,659,300	$8,687,119	$6,643,815	$4,519,250	$2,308,536	$0	$0	$0	$0	$0
Amortization of Loan Fees	$181,248	$175,969	$170,843	$165,867	$0	$0	$0	$0	$0	$0	$0
Insurance	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785	$2,533,785
Amortization of Start-up Expenses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$73,195,848	$71,014,360	$68,776,647	$66,475,045	$63,940,353	$61,490,691	$58,950,725	$58,726,096	$58,508,009	$58,296,274	$51,238,444
Pre-Tax Profit	$474,930	$2,656,418	$4,894,131	$7,195,733	$9,730,425	$12,180,147	$14,720,053	$14,944,682	$15,162,769	$15,374,504	$22,432,334
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$397,963
State Tax, Sales Tax, Property Tax	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000
Profit After Taxes	$465,930	$2,647,418	$4,885,131	$7,186,733	$9,721,425	$12,171,147	$14,711,053	$14,935,682	$15,153,769	$15,365,504	$22,025,371

Income / Expenses in Actual Year Dollars

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Discount Factor:	1.00	1.00	1.00	0.97	0.94	0.92	0.89	0.86	0.84	0.81	0.79
Total Income											
Sales of Ethanol and Co-Products	$0	$30,573,373	$73,670,778	$75,880,901	$78,157,328	$80,502,048	$82,917,110	$85,404,623	$87,966,762	$90,605,765	$93,323,937
Total	$0	$30,573,373	$73,670,778	$75,880,901	$78,157,328	$80,502,048	$82,917,110	$85,404,623	$87,966,762	$90,605,765	$93,323,937
Total Expenses											
Feedstock	$0	$14,700,000	$29,400,000	$30,282,000	$31,190,460	$32,126,174	$33,089,959	$34,082,658	$35,105,138	$36,158,292	$37,243,040
Operating Chemicals	$0	$3,463,737	$6,927,473	$7,135,298	$7,349,357	$7,569,837	$7,796,932	$8,030,840	$8,271,766	$8,519,918	$8,775,516
Process Water	$0	$723,198	$1,446,396	$1,489,788	$1,534,482	$1,580,516	$1,627,931	$1,676,769	$1,727,072	$1,778,885	$1,832,251
Natural Gas	$0	$781,200	$1,562,400	$1,609,272	$1,657,550	$1,707,277	$1,758,495	$1,811,250	$1,865,587	$1,921,555	$1,979,202
Disposal Costs	$0	$156,870	$313,740	$323,152	$332,847	$342,832	$353,117	$363,711	$374,622	$385,861	$397,436
Maintenance Materials	$0	$1,036,100	$2,072,200	$2,134,366	$2,198,397	$2,264,349	$2,332,279	$2,402,248	$2,474,315	$2,548,545	$2,625,001
Miscellaneous Incidentals	$0	$445,000	$445,000	$458,350	$472,101	$486,264	$500,851	$515,877	$531,353	$547,294	$563,713
Salaries / Wages	$0	$2,876,478	$6,537,450	$6,733,573	$6,935,580	$7,143,648	$7,357,957	$7,578,696	$7,806,057	$8,040,239	$8,281,446
Depreciation	$0	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483
Interest Expense	$0	$15,440,796	$27,871,637	$27,081,541	$26,162,935	$25,164,216	$24,056,306	$22,826,521	$21,461,462	$19,946,247	$18,264,359
Amortization of Loan Fees	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487	$236,487
Insurance	$0	$2,533,785	$2,533,785	$2,609,799	$2,688,093	$2,768,735	$2,851,797	$2,937,351	$3,025,472	$3,116,236	$3,209,723
Amortization of Start-up Expenses	$0	$1,383,984	$1,383,984	$1,383,984	$1,383,984	$1,383,984	$0	$0	$0	$0	$0
Total	$236,487	$55,793,097	$92,746,014	$93,473,072	$94,157,138	$94,789,780	$93,977,594	$94,477,891	$94,894,814	$95,215,041	$95,423,657
Pre-Tax Profit	($236,487)	($25,219,724)	($19,075,236)	($17,592,171)	($15,999,805)	($14,287,732)	($11,060,484)	($9,073,268)	($6,928,053)	($4,609,276)	($2,099,719)
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
State Tax, Sales Tax, Property Tax	$0	$0	$0	$0	$0	$0	$0	$10,433	$10,746	$11,069	$11,401
Profit After Taxes	($236,487)	($25,219,724)	($19,075,236)	($17,592,171)	($15,999,805)	($14,287,732)	($11,060,484)	($9,083,701)	($6,938,799)	($4,620,345)	($2,111,120)

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Discount Factor:	0.77	0.74	0.72	0.70	0.68	0.66	0.64	0.62	0.61	0.59	0.57
Total Income											
Sales of Ethanol and Co-Products	$96,123,656	$99,007,365	$101,977,586	$105,036,914	$108,188,021	$111,433,662	$114,776,672	$118,219,972	$121,766,571	$125,419,568	$129,182,155
Total	$96,123,656	$99,007,365	$101,977,586	$105,036,914	$108,188,021	$111,433,662	$114,776,672	$118,219,972	$121,766,571	$125,419,568	$129,182,155
Total Expenses											
Feedstock	$38,360,332	$39,511,142	$40,696,476	$41,917,370	$43,174,891	$44,470,138	$45,804,242	$47,178,369	$48,593,720	$50,051,532	$51,553,078
Operating Chemicals	$9,038,782	$9,309,945	$9,589,243	$9,876,921	$10,173,228	$10,478,425	$10,792,778	$11,116,561	$11,450,058	$11,793,560	$12,147,367
Process Water	$1,887,219	$1,943,835	$2,002,150	$2,062,215	$2,124,081	$2,187,804	$2,253,438	$2,321,041	$2,390,672	$2,462,392	$2,536,264
Natural Gas	$2,038,578	$2,099,735	$2,162,727	$2,227,609	$2,294,437	$2,363,270	$2,434,168	$2,507,193	$2,582,409	$2,659,881	$2,739,676
Disposal Costs	$409,360	$421,640	$434,290	$447,318	$460,738	$474,560	$488,797	$503,461	$518,564	$534,121	$550,145
Maintenance Materials	$2,703,751	$2,784,864	$2,868,409	$2,954,462	$3,043,096	$3,134,388	$3,228,420	$3,325,273	$3,425,031	$3,527,782	$3,633,615
Miscellaneous Incidentals	$580,624	$598,043	$615,984	$634,464	$653,498	$673,102	$693,296	$714,094	$735,517	$757,583	$780,310
Salaries / Wages	$8,529,889	$8,785,786	$9,049,359	$9,320,840	$9,600,465	$9,888,479	$10,185,134	$10,490,688	$10,805,408	$11,129,570	$11,463,458
Depreciation	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$0
Interest Expense	$16,397,462	$14,325,208	$12,025,005	$9,471,779	$6,637,699	$3,491,870	$0	$0	$0	$0	$0
Amortization of Loan Fees	$236,487	$236,487	$236,487	$236,487	$0	$0	$0	$0	$0	$0	$0
Insurance	$3,306,015	$3,405,195	$3,507,351	$3,612,572	$3,720,949	$3,832,577	$3,947,554	$4,065,981	$4,187,961	$4,313,599	$4,443,007
Amortization of Start-up Expenses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$95,503,980	$95,437,362	$95,202,964	$94,777,519	$93,898,565	$93,010,097	$91,843,309	$94,238,144	$96,704,824	$99,245,504	$89,846,922
Pre-Tax Profit	$619,675	$3,570,003	$6,774,622	$10,259,395	$14,289,457	$18,423,565	$22,933,362	$23,981,828	$25,061,747	$26,174,064	$39,335,233
Income Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$697,650
State Tax, Sales Tax, Property Tax	$11,743	$12,095	$12,458	$12,832	$13,217	$13,613	$14,022	$14,442	$14,876	$15,322	$15,782
Profit After Taxes	$607,932	$3,557,908	$6,762,164	$10,246,563	$14,276,240	$18,409,951	$22,919,341	$23,967,385	$25,046,871	$26,158,742	$38,621,822

Value of Assets at Year End in Individual Year Dollars

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Fixed Assets											
Plant and Equipment	$100,561,510	$140,370,873	$228,294,177	$216,278,694	$204,263,211	$192,247,728	$180,232,245	$168,216,762	$156,201,279	$144,185,796	$132,170,313
Less Accumulated Depreciation	$0	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483
Other	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Long-term Assets	$100,561,510	$128,355,390	$216,278,694	$204,263,211	$192,247,728	$180,232,245	$168,216,762	$156,201,279	$144,185,796	$132,170,313	$120,154,830

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Fixed Assets											
Plant and Equipment	$120,154,830	$108,139,347	$96,123,864	$84,108,381	$72,092,898	$60,077,415	$48,061,932	$36,046,449	$24,030,966	$12,015,483	$0
Less Accumulated Depreciation	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$12,015,483	$0
Other	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Long-term Assets	$108,139,347	$96,123,864	$84,108,381	$72,092,898	$60,077,415	$48,061,932	$36,046,449	$24,030,966	$12,015,483	$0	$0

Net Present Value Analysis

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Adjusted Total Profit	($236,487)	($25,219,724)	($19,075,236)	($17,079,777)	($15,081,351)	($13,075,299)	($9,827,097)	($7,836,681)	($5,811,135)	($3,756,763)	($1,666,538)
Adjusted Value of Profit minus Debt Payment	$0	$2,473,042	$21,046,370	$21,086,880	$21,127,816	$21,165,811	$22,432,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334
Adjusted Value of Capital Investment plus Interest	$0	$15,440,796	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Adjusted Total Profit	$465,930	$2,647,418	$4,885,131	$7,186,733	$9,721,425	$12,171,147	$14,711,053	$14,935,682	$15,153,769	$15,365,504	$22,025,371
Adjusted Value of Profit minus Debt Payment	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,423,334	$22,025,371
Adjusted Value of Capital Investment plus Interest	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$35,236,144	$0	$0	$0	$0	$0

Present Value of Profit	$604,074
Present Value of Capital Investment	$253,378,516
Present Value of Profit minus Debt Payment	$445,286,099
Present Value of Capital Investment Plus Interest	$543,082,955
Baseline Cost per Gallon of Ethanol	$1.15

First Year Cost-per-Gallon Analysis

Expense Category	Year One Cost	Cost per Gallon
Feedstock	$29,400,000	$0.459
Operating Chemicals	$6,927,473	$0.108
Process Water	$1,446,396	$0.023
Natural Gas	$1,562,400	$0.024
Disposal Costs	$313,740	$0.005
Maintenance Materials	$2,072,200	$0.032
Miscellaneous Incidentals	$445,000	$0.007
Salaries / Wages	$6,537,450	$0.102
Depreciation	$12,015,483	$0.188
Interest Expense	$27,871,637	$0.435
Amortization of Loan Fees	$236,487	$0.004
Insurance	$2,533,785	$0.040
Amortization of Start-up Expenses	$1,383,984	$0.022
Profit	-$19,075,236	-$0.298
Total	$73,670,778	$1.150

Summary of Transportation Costs

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cost of transport												
Ethanol from Plant to Consumer	$0	$1,080,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000
CO2 from Plant to Consumer	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Feedstock from Farm to Plant	$0	$3,087,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000
DDGS from Plant to Farm	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Yearly Transport Costs	$0	$4,167,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Cost of transport										
Ethanol from Plant to Consumer	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000	$2,700,000
CO2 from Plant to Consumer	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Feedstock from Farm to Plant	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000	$6,174,000
DDGS from Plant to Farm	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Yearly Transport Costs	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000	$8,874,000

Bridge-to-Corn-Ethanol Subcontract Summary Sheet
NYSTEC
Technical Advisor: J. Sheehan

Industrial Partner: Robbins Corn Processing
Other Partners: New York State Corn Growers' Association, Raytheon Engineers and Constructors

Starch to Ethanol Process Information

Feedstock: Corn
Facility Capacity: 5MM and 29MM gallons per year
Ethanol Yield: 2.5 gallons per bushel
Other Products: Animal feed

Biomass Process Information

Size of Biomass Process: 60MM gallons per year
Ethanol Yield: NREL Base Case for Hardwood Sawdust
Feedstock: Corn Stover
Process: Co-current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis
Fermentative Organism: NREL *Zymomonas mobilis*
Steam: Produced by biomass burner / turbogenerator
Electricity: Excess sold at $0.035/kwh per Niagara Mohawk quote
Other Information: Tried getting quote on purchased enzyme, but was unable to get firm price

Links with Existing Facility

None. Grassroots facility.

Capital and Operating Costs

Biomass Plant Capital Investment: $3.83 per annual gallon of capacity
Total Operating Costs: $0.79 / gal ethanol
Feedstock Cost: $30 / dry ton (plus $7.75/dry ton transportation cost)
Chemical and Disposal Cost: $0.15 per gallon

Proforma

Solved for Cumulative Profit after 20 years: $604,070
Equivalent to Average Annual Return of 0.3%
Ethanol Selling Price: $1.15 / gal
Plant Life: 20 years
Financing: 30% Equity – Loan at 11% with 15 year term
Depreciation: 15 year straight line

SensitivityAnalysis

Range of reduced capital, debt/equity ratios, ethanol prices, feedstock costs

Strengths of Subcontract

Design and Costing for Corn Stover Handling
Design and Costing of fermentors for biomass plant (Raytheon increased vessel size)
Analysis of cost and availability of biomass
Engineering Company Verification of Many Equipment Costs
Labor Requirement Calculations

Subcontract Recommendations/Next Steps

Pursue business plan for corn ethanol and track R&D for reductions in capital investment of biomass ethanol plant.